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PREVENTING DEER CONCENTRATIONS

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One of the cardinal principles of wildlife management calls for the maintenance of an abundance of food and cover throughout all seasons of the year. This is widely appreciated as important for game birds and small mammals but is not so well recognized in the case of deer.

It is the writer's contention that deer are most urgently in need of consideration as regards cover, especially for the winter season. Across northern Michigan, Wisconsin and Minnesota we have distressing examples of crowding where during the winter deer in large numbers occupy small areas that have good cover but where food is insufficient. Large numbers, especially of the fawn and yearling classes, die of starvation each year. This occurs despite the fact that an abundance of suitable food may exist near where the losses occur. The trouble is that deer, like cattle on the range during cold weather, congregate in areas attractive because of the cover without realizing that food will be insufficient for the needs of such large numbers in the restricted areas occupied.

We must do with the deer just as we do with pheasants—provide cover where food exists. In other words, what is needed in the north country is to spread or scatter the deer into localities where there is plenty of food. In Manitoba there are vast areas of burned-over country coming up to young aspen, birch, hazel and other plants providing good food for deer. Most of this is not available as browse in the winter time due to lack of the thick, evergreen cover the deer and elk need for protection and comfort. Wherever there exists a patch of spruce, balsam, or cedar, however, even though the area be only a few acres in extent, one finds deer or elk or both—and sometimes moose also, occupying it. From these dense, warm stands of evergreen forest, where the big game species conceal themselves during the day, the animals range out into the surrounding second growth and brush to browse during the night. This is the case so often that in hunting big game in Manitoba it proved to be an easy matter to jump animals in practically every patch of evergreen growth where the trees were large enough and close enough together to form good cover.

With the great value of cover in mind, we are making a beginning in establishing special dense but small plantations of white spruce, white pine, arbor vitae and balsam within large areas of young deciduous species that have come in where former logging operations and fires occurred. In this way it is believed that the deer can be dispersed over a much wider territory instead of remaining "yarded" so closely during the winter.

In northern Minnesota an additional practice is needed. There it is common to find some large cedar swamps (arbor vitae) practically untouched while in nearby swamps deer are concentrated and dying of starvation. Such conditions require the actual breaking of trails through the deep snow and the driving or coaxing of the deer (by scattering hay along the trail) to the unused swamp areas where food is abundant.

Farther south in the Lake States, where hardwood forests occur and where snow does not become so deep, deer naturally spread out over large areas where they find an abundance and variety of browse and where they can paw for acorns. This is one reason why the hardwood forests, except where over-shot, have always been able to sustain large deer populations.

It must be borne in mind that originally deer did not range in great numbers in the deep snow country. In such territory, their place was taken by moose and caribou.

Deer in northern Michigan and in the extreme northern and northeastern districts of Minnesota are, therefore, outside of their natural range. They have been induced to enter this territory by the presence of extensive brush and second growth timber areas, the result of widespread logging operations and fire. There is an abundance of food for even more than the present deer population but unless it is made available to the animals during the winter there will be an increasingly heavy loss, especially of the young, through starvation. The only way to make more of the browse available is to break up the deer concentrations or "yards" by getting the animals into suitable cover in many places scattered through the large areas of good browse. It will take five to ten years, depending on the size of the planting stock, to establish new coverts through planting. In the meantime, much relief from the present congestion may be attained through inducing some of the deer in a "yard" to move into and occupy other swamp areas in which and around which suitable food exists in sufficient quantity.

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WISCONSIN PHEASANT MOVEMENT STUDY, 1936–37

Aldo Leopold, Orville S. Lee, and Harry G. Anderson[1]

Ohio has shown that wild pheasants for restocking purposes can be produced in quantity and at surprisingly low costs. The wild birds are live-trapped from refuges in which they concentrate during the winter. Hicks (1) reports one township, which, after sustaining a legal kill of 2,366 cocks, yielded 2,049 trapped pheasants from its central refuge. The residual breeding stock of 800 birds was sufficient to repeat a similar yield the next year. The refuge was maintained at a cost of 24 cents per trapped pheasant; the trapping and distribution cost 14 cents per bird. The total cost is thus under 40 cents per bird—about one-quarter the usual cost for adult pheasants artificially propagated on game farms.

It may safely be assumed that wild-trapped stock is of superior quality, but there are important limitations on the season of capture. Iowa (2) and South Dakota (3) captured wild stock by "shining" in fall. Large-scale trapping, however, is possible only in winter, and the trapped stock cannot be held over without costly and injurious storage. Will winter releases of trapped stock survive and "stay put" in strange surroundings? Hicks (1) finds that in Ohio a wild-trapped bird released in winter is about twice as likely to survive as an adult artificially propagated bird released at the same season, and about five times as likely to survive as an immature captivity-bred bird released in late summer. He also finds that wild-trapped winter releases tend to "stay put."

Is it possible to obtain equally good stability and survival in the more rigorous climate of Wisconsin?

An opportunity to throw light on this question arose in 1936. Two refuges on lands of the University of Wisconsin showed damage to corn in spring, and a surplus of pheasants in the fall. This surplus was trapped, marked, and removed to other localities.

This paper describes the methods of trapping and marking, and the movements and mortality after release.

Refuge Populations

A drive made on the Arboretum Refuge on December 8 flushed 179 pheasants on 800 acres. The population was estimated as at least 200, a density of 1 pheasant per 4 acres.

No fall census was made on the University Bay Refuge, but the winter removals plus the residual breeding stock (censused in February) indicate an early winter population of 220 pheasants on 500 acres, or one per 2.3 acres.

The following pheasants were trapped from these refuges, feather-marked, banded, and released elsewhere:

[1] This is a group effort. Ellwood B. Moore, Arthur S. Hawkins, and Douglas E. Wade of the University of Wisconsin and C. E. Gordon of the Soil Conservation Service helped make the releases and contributed observations on their movements. Harold Shine of the State Conservation Department supervised the trapping, helped with the marking, and also observed releases. Farmers reported the appearance of marked birds at their feeding stations.

	Cocks	*Hens*	*Indeterminate*	*Total*
From Arboretum	31	49	1	81
From University Bay	46	82	1	129
Totals	77	131	2	210

TRAPPING

Baiting at the trapping sites was begun December 6, 1936. Trapping was postponed until January 6 on account of snowless weather. It continued intermittently until January 30, 1937.

Traps were mesh-covered portable frames 36″×24″ and 14″ high, with a wire entrance funnel at each end. Both 1″ and 2″ wire mesh were used, the former being better.

The wire funnel requires adjustment as to size of opening. Birds escaped when openings were too wide, refused to enter when too narrow. The principle of this funnel is illustrated on page 50, *Manual for Bird Banders* (4).

The traps were baited with shelled corn placed on the ground in the center. Wheat was tried but was consumed by small birds. Other grains are less palatable to pheasants (5) than corn and wheat.

Traps were visited twice daily. The catch per trap ran as high as five birds.

Sex Ratio in Traps. The traps operated selectively against the hens, the season's catch being double that of cocks. The census drives which preceded the trapping showed no such differential in the population; there were as many cocks as hens.

The sex ratio of the daily total catch fluctuated between wide limits; for example, 12 cocks: 4 hens, 19 hens: 1 cock. It is well known that the sexes often congregate in separate flocks during the late fall and winter. Perhaps a given kind of weather affects the activity of the hen-flocks differently from the cock-flocks, and this in turn affects the sex ratio of the catch. Some such hypothesis seems to be the only way to explain how a score of traps could collectively yield such a variable sex ratio.

Scalping. The trapped birds tended to scalp themselves in their efforts to escape. Scalping was reduced by substituting fish-net for wire-mesh tops, or by covering the top lightly with weeds and grass. A false top of net can be inserted beneath the wire top, but this requires a larger trap-frame with more head room.

The seriousness of scalp wounds is not known. One hen with a healed scalp was seen on a nest four months after release.

Trapping Sites. Traps should be set in or near tall vegetation. When trapped in the open, pheasants observe the approach of the trapper and have more time to scalp themselves. Feeding shelters are good sites. Traps set near natural food yield no catch.

Apparently promising sites may yield no catch; for example, traps were set under a 20-year-old conifer windbreak used by many pheasants as a roost, but without success. The birds evidently did not feed under these roost-trees.

Handling and Storage. In removing a pheasant from a trap, and in all subsequent handling, both of the feet should be grasped. A bird held by one leg may dislocate it. The feathered portion of the legs should not be handled because the feathers are easily lost.

The pheasants removed from the traps were placed in gunny sacks and later transferred to darkened crates.

No more than 2 or 3 birds should be placed in one sack. Crates should never be tilted, especially after markers are attached. Birds should not be held in crates longer than 24 hours. They eat readily in the crates.

In practical (as distinguished from experimental) operations it would be unnecessary to feather-mark, and hence unnecessary to hold birds over night. This should reduce shock, and improve survival above that here reported.

Interference. Cottontail rabbits, fox squirrels and gray squirrels interfered with the trapping. Pheasants would not approach a trap with a squirrel nearby, nor enter a trap containing one. Trapped rabbits and squirrels scattered the bait and escaped by cutting holes in the fish-net tops, thus permitting the escape of pheasants subsequently entering the trap.

Rabbits were very wild when trapped, always injuring themselves and often escaping by battering the funnel.

Squirrel trouble was worst during fair weather. The largest pheasant catches were obtained on stormy days, perhaps because of lesser interference from squirrels.

Small dogs entered the traps and killed pheasants. Larger dogs upset the traps. A gray fox killed a pheasant in a trap. A horned owl was flushed from a trap after it had killed a pheasant by reaching through the mesh with its foot.

The total trap mortality from predators and trap injuries was 4 per cent of the pheasants caught.

FEATHER-MARKING

Before release each pheasant was marked with a white or bright-colored feather fastened to its dorsal tail feather. The marker on a winter-trapped bird should theoretically be retained until the moult of the following August, but we have no actual record of markers retained beyond July.

Feather-marking has been used for ruffed grouse studies by Ralph King in Minnesota and Gardiner Bump in New York, it is being used in a California quail study by John T. Emlen, Jr., but none of these investigators have described their technique. Butts (6) describes the use of stains and paints, but not feathers, for marking small birds. Heydweiller (7) apparently published the first description of feather-marking. Lee and Anderson (8) have prepared a detailed discussion of the technique here described.

Feathers. The secondaries and tail feathers of white chickens and the wing coverts of white geese and turkeys were used as markers. Stiff curved primaries are unsuitable because they bend the shaft to which they are attached. Feathers picked "wet" from commercial poultry are useless because their resilience has been destroyed.

Colors. Markers were dyed red, orange, yellow, pink, or green with Diamond wool dye, and some left white, giving six kinds. To dye markers, first wash them in vinegar and then boil for 15 minutes in the dye. Feathers so prepared retain recognizable color up to six months. Unwashed feathers, or those boiled only a short time, fade within two months. These data on color-fastness have been checked by exposure tests, as suggested by Butts (6), and by the observation of recognizable markers in the field as late as July 17.

As an alternative for dyed markers one may use natural feathers of pure bright color or bold pattern gathered from zoological gardens.

Trimming. The shaft of the marker should be flattened at its base with a sharp flesh knife, followed by sandpaper. No marker should be much wider or longer than the tail feather to which it is attached, but it must be long enough to project beyond the tail coverts.

Weighing. Before attaching the marker, the bird should be weighed, banded, and the sex recorded. To keep the bird quiet and to reduce ruffling, it was inserted head first into the open end of a woolen sock from which the toe had been cut and then closed by an elastic. After weighing and banding, the elastic was removed and the bird pushed through the open toe, head first.

Banding. All pheasants were banded with Wisconsin Conservation Department bands, size 7. This size was large enough for the largest cocks, but size 6 would have fitted most hens.

Fastening the Marker. With the help of the confining sock, one man can attach a marker, but it is preferable to have a helper.

First coat the underside of the marker and a corresponding section at the base of the dorsal tail feather with DuPont's Household Cement. Let dry, recoat, and then lay the marker on the tail feather, attaching it firmly with three ties of waxed linen thread. Use square knots and dab each knot with cement.

More than one marker per bird proved to be hard to see in the field. In pheasants, the tail is not spread enough to show more than one. Bicolored single markers would give two colors for each bird, but would increase the labor of dyeing.

Feather-marking can be done in the field, but our birds were taken into a room warm enough to permit the handling of thread, cement and pencils without gloves. It is inadvisable to use a fully-heated room.

Releasing. We did not succeed in releasing birds in daylight without their flushing on leaving the crate. We released them in the open within plain sight of the desired cover, and let them fly to it.

A non-flying release was found possible at dusk by placing the crate in cover and under overhanging limbs.

MOVEMENTS AND SURVIVAL AFTER RELEASE

A total of 15 releases varying from 10 to 22 pheasants each was made. The sexes in each release were balanced as far as the differential catch of hens at the traps would allow.

Release areas were selected to represent contrasting conditions of cover, food, topography, density of resident population, and distance from home range. Movements after release were traced by observing or retrapping feather-marked birds, by return of bands from birds found dead, and in one case by observing a healed scalp wound on an incubating hen.

Of the 15 releases, one is discarded as yielding nothing of value. The remaining 14 are described in four groups, each emphasizing a single variable. It should be understood, however, that no complete segregation of variables was possible, i.e., each group sheds

some light on all the four variables studied.

Group A. Return to Home Range. The maximum distance from which any pheasant returned to its home range was one mile. Hence we compare here only those releases made within a short distance of the two ranges trapped. All birds were moved to the point of release in covered crates. This excludes the possibility that they oriented themselves by observing the route.

1. 10 University Bay birds released January 9 at a point one mile from University Bay, but separated from it by a highway. No returns to home range.

(Release was made in a fed upland covert of fair density but devoid of resident birds. In others years resident birds had deserted this covert in winter, despite feeding. These introduced birds stayed better than the residents, as evidenced by the following marked birds seen at the release point: 7 on January 22, 8 on February 23, 4 on March 16, 1 on April 17, 4 on May 13. Mortality: 1 hen found March 22 had been killed by a predator.)

2. 22 Arboretum birds released January 9 and 28 one mile from the Arboretum. Two returns to home range: a hen on March 10 and a crowing cock on April 24.

(Release was made on a fed marsh of inferior density containing 18 resident pheasants. Marked birds seen at release point: 8 on February 25. Dispersion: a cock found dead 2½ miles away on May 15.)

3. 11 University Bay birds released January 9 and 11 two miles from University Bay. No returns to home range.

(Release was made on an unfed marsh with poor cover but with a fair upland thicket nearby. No birds seen at release point subsequent to release. Dispersions: 2 cocks and 1 hen fed at a farmyard one mile away February 2–23, 1 hen seen February 1 and again April 17 on a fed marsh five miles away, 1 hen found dead April 6 in a rabbit trap two miles away.)

Conclusions: Of 43 birds released at short distances, only two returned to their home range, and these from a distance of only one mile, and after the lapse of two months' time. This proportion is so small, the distance so short, and the elapsed time so long as to suggest that random dispersal, rather than oriented movement, accounts for the returns.

Group B. Holding Power of Food and Cover. Release A-3 (already described) was on unfed range with poor cover. Releases A-1 and A-2 were made on fed range with poor cover. These may now be compared with two releases on fed range with good cover:

4. 19 birds released January 10 and 27 on a well-fed well-covered marsh. Three moved 2½ miles to another feeder, at least 8 stayed where released, none dispersed.

(This marsh was in the sandy region of Columbia County, ordinarily considered inferior in holding power. There was a moderate population of resident birds. More than 8 birds stayed where released, but the observer failed to record date, number, and sex.)

5. 10 birds released January 9 on a well-fed marsh with spotty cover. Two were seen April 15, none dispersed.

(This is a marshy creek ordinarily with heavy cover but this year thinned by drouth. A drive made on February 3 in poor light showed 25 pheasants but no visible markers.)

Conclusions from Groups A and B: Of 11 birds released where both food and cover were poor, all dispersed. Of 32 birds released on good food but fair or poor cover, some dispersed but some held. Of 29 birds released on good food and good cover, none are known to have dispersed farther than to a nearby feeder.

Group C. Holding Power of Uplands. Topographic Orientation. A great part of southwestern Wisconsin is upland

prairie with little or no winter cover. The sparse pheasant population moves to the river bottoms in winter and returns to the uplands in spring. Query: Will wild birds released on upland follow the already-departed resident birds to the lowlands, or will they stay put?

6. 20 birds released January 13 in a bare foodless upland valley. None stayed. Ten dispersed groups totalling 14 birds were seen at points up to 9 miles distant during ensuing six months. Dispersal showed no topographic orientation.

(There are wooded hills above the release point and good marshes 2–6 miles downstream. There were no resident birds. Detail of dispersals: A banded bird was seen next day one mile downstream. Two cocks and a hen appeared two days later at a farmyard ½ mile away and were fed there until March 21. Eight other singles and pairs seen in every direction from release point at various dates up to May 16. A cock was killed by an automobile ½ mile from release point on July 15; on the same day another cock was seen in a field nearby. Two cocks were flushed from an alfalfa field 1½ miles away July 17.)

7. 10 birds released January 15 on bare upland prairie especially prepared with brushpiles, shelters, and feeding stations by C. E. Gordon of the Soil Conservation Service. Resident birds had gone downstream in fall. Dispersals: none known. Stayed: 7 birds seen regularly at a station ¾ mile from point of release. Mortality: 1 cock on April 8 at point of release; 1 hen with 15 chicks killed by haymower July 7 at a point 2¼ miles distant.

8. 20 birds released January 8, one group on a creek between well-covered, well-fed marshes lying up and downstream respectively, another in adjacent well-fed upland thickets. There was local dispersion in both cases, the upland group tending to move downhill; the creek bottom group moving both up and downstream.

Conclusions: Food plus artificial cover will hold winter releases even on the barest uplands, but releases on unfed uplands disperse at random.

If food and cover are good, there is no conclusive up or downhill orientation of long-distance movement, but upland releases move to bottomland coverts if they are visible from the uplands.

Group D. Population Pressure and Dispersal. No census of resident pheasants preceded the releases so far described. The following, however, were made on the Faville Grove and Elkhorn game areas where the resident birds in each covert had been counted, and where the movements of the introduced birds were traced by continuous retrapping and field observations:

9. 15 birds released January 19 and 21 in a well-fed 10-acre tamarack bog containing 35 resident birds. Five stayed, as shown by subsequent retrapping. Three dispersed to various points a mile away. More may have dispersed, for a census drive two days after release flushed 2/3 of the resident birds but only 1/15 of the planted birds.

(Counting the surrounding feeding area, the density was four acres per bird before release, three acres after. Cover perfect. No known mortality.)

10. 10 birds released January 21 at a fencerow feeder flanked by good fallow and thin marsh containing one resident bird per 10 acres. Three stayed, six dispersed in random directions.

(This release is almost completely accounted for. No known mortality. One marked hen known to have raised a brood ¾ mile away.)

11. 10 birds released January 23 in well-fed 5-acre peat marsh grown to tall weeds and containing 15 resident birds. Five stayed. One moved 1½ miles, 1 found dead, 3 probably moved.

(This marsh was burned five years ago. In the giant ragweed stage following the burn, it was birdless. As aster-goldenrod came in, it began to hold pheasants, but they range in winter over surrounding fragments of upland cover, often without returning at night.)

12. 11 birds released January 23 in a well-fed 100-acre tamarack marsh containing 100

resident birds. Most stayed, 1 moved a mile, 4 killed by predators.

(Counting the surrounding feeding area, the density of two acres per bird was raised only slightly by the release. Cover excellent.)

13. 12 birds released January 17 in 20 acres of uncut weedy rye, unfed, and nearly deserted by resident birds. None stayed. At least 4 stopped at surrounding feeding stations and stayed. Dispersal was random in direction.

(The rye was surrounded by marshy haymeadows, mostly mowed, but with patches of bush willow. Area considered too poor in cover to feed. Resident density 1 bird per 30 acres.)

14. 21 birds released January 15 and 21 on the bare end of a farm in sight of well-fed marshy thickets at the other end. 6 seen in these thickets next day; marked birds seen and retrapped there for rest of winter.

(The terrain is flat. The release point had been deserted by resident birds, but the marshy thicket was heavily populated. No known dispersal or mortality.)

Conclusions: Pheasants released in a good well-fed cover, already populated, did not disperse, but did suffer considerable predation. It is not certain, however, that the predation rate was heavier than in the resident birds; it may simply reflect the combined density of the two, as would be expected from the Errington concept of a "threshold of vulnerability" (9). The predation data, however, are much too crude to either support or refute the applicability of the Errington theory.

Pheasants released on bare terrain in sight of good well-fed cover promptly moved to it and stayed there despite heavy pre-existing population.

Pheasants were sometimes restless in coverts of less than 10 acres. Where small coverts prevailed, both resident and released pheasants adopted a "circuit" type of movement, travelling from one covert to another in sequence spreading over a mile of distance and several days time. (This type of ranging is uncommon in the smaller game birds, but common in the larger carnivores.) As in groups A–C, inadequate food induced prompt dispersal in seemingly random directions.

CORN DAMAGE ON REFUGES

When the game manager establishes a pheasant refuge he seldom considers crop damage, but he is often forcibly reminded of it at a later date.

Winter pheasant concentrations are inherent in the present "system" of accidental coverts. A mobile species on clean-farmed range will surely move in fall to the best winter cover, especially if fed and protected there, and the spring dispersion from that cover is bound to be incomplete. Hence the stage is set for crop damage near refuges. It is evident that the Ohio plan, by its artificial dispersion of refuge pheasants, tends to relieve spring congestion and hence damage.

The experimental dispersions here described afforded an excellent chance to observe whether reductions in pheasant density are followed by a decrease in damage.

University Bay Refuge. This property is used by the University to grow inbred seed corn. To avoid contaminating pollens, such corn is grown on small fields surrounded by woods. These isolated fields are particularly vulnerable to pheasants.

Feeding and protection on the University Bay Refuge began in 1934. The first severe corn-pulling promptly followed in the spring of 1935. A rough census that fall showed about 250 pheasants, or a bird per two acres for the range unit.

In 1936, despite the shooting of 35

pheasants by a patrolman, a third of the corn on a 12-acre field had to be replanted, while three small plots were replanted as many as three times. The occurrence of hayfield nests in densities as high as two per acre (10) afforded further evidence of abnormal congestion that spring.

The fall population in 1936 was 220 pheasants, or a bird per 2.3 acres. This was reduced by the trapping operations here described to 90 birds, or one per 5.5 acres.

The spring damage in 1937 was again serious, *despite the 60 per cent reduction* in population by trapping, and a further reduction of 9 per cent by shooting. The 12-acre field was not hurt, but one of the three smaller plots had to be replanted.

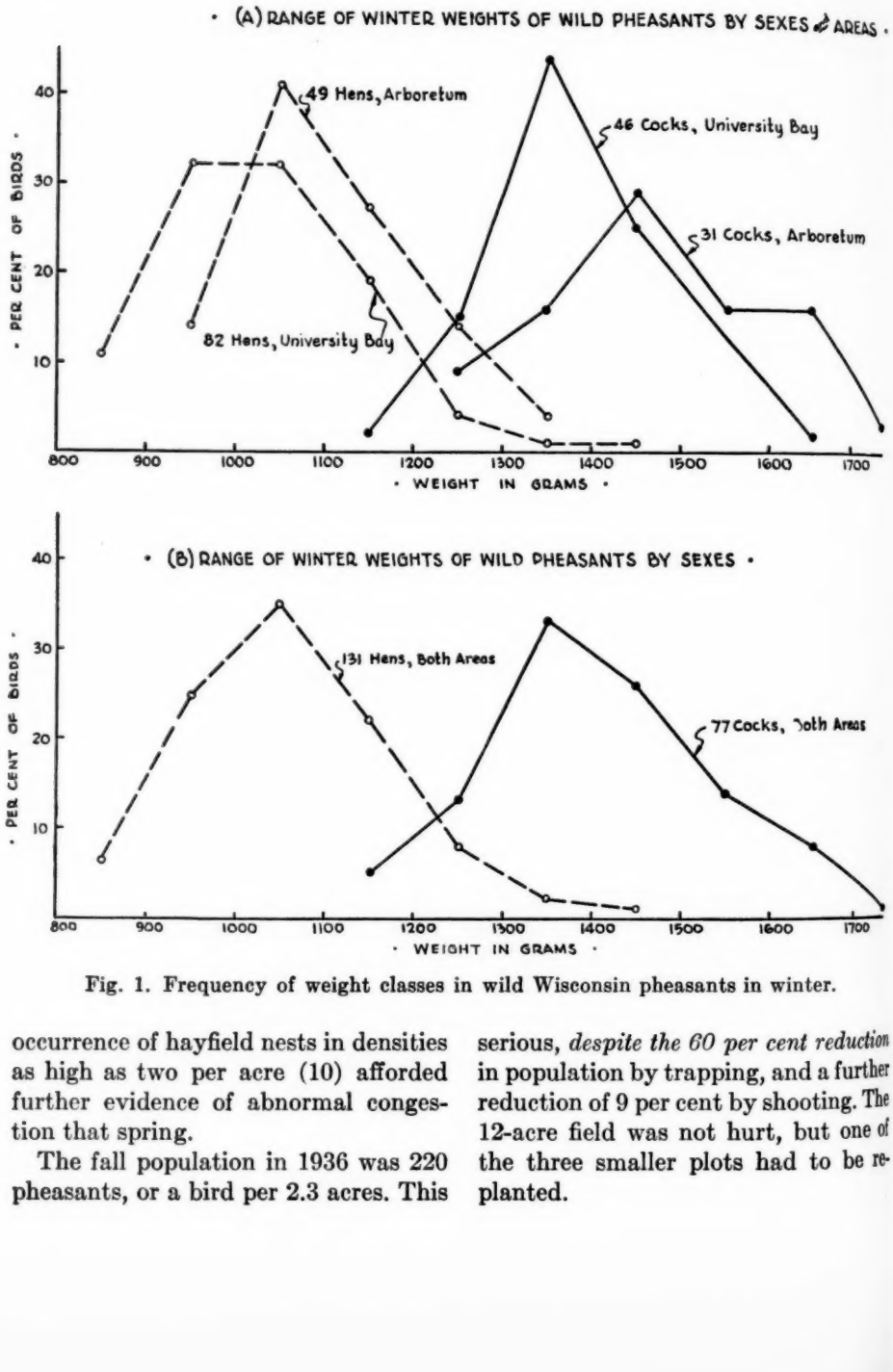

Fig. 1. Frequency of weight classes in wild Wisconsin pheasants in winter.

A reduction by trapping to 75 instead of 90 breeding birds has been decided on for 1938.

Other Areas. The Arboretum, and the two tamarack bogs at Faville Grove (releases 9 and 12) all have a denser population than that left on University Bay after the 1937 trapping; nevertheless they sustained little damage. The lesson seems to be that corn-pulling, once established as a habit, is hard to eradicate even by stringent reductions. Conclusion: Trap hard enough to prevent its getting started.

WEIGHTS OF PHEASANTS

An analysis of the weights of the 208 trapped pheasants of determinable sex is presented in Figure 1. The upper group of curves (A) depicts the frequency of various weight classes in both sexes and both areas. The lower group (B) combines the weights from both areas, and may be assumed to represent winter weights of fed pheasants in this region.

The upper curves disclose a distinct and consistent difference between the Arboretum and the University Bay pheasant weights. The Arboretumcocks are 100 grams heavier and the Arboretum hens 50 grams heavier.

The reasons for this discrepancy are puzzling and perhaps important. The two areas are only two miles apart. There are no known differences in racial origin of the pheasants.

The heavy birds have a range more lightly populated, richer in heavy marsh, but poorer in crop residues than the range of the light birds. Both ranges are well fed and have plenty of ungrazed woods.

An insufficient sample of wild-trapped pheasants from the Faville Grove Game Area indicates light birds weighing about the same as those from University Bay; Faville Grove has both extensive marshes and heavy crop residues, but a much lighter average population (1 pheasant per 12 acres). The weight discrepancy, then, must simply be recorded as a fact not yet accounted for.

The maximum and minimum individual weights of the 208 trapped pheasants were as follows:

Location	*Heaviest cock*	*Heaviest hen*	*Lightest cock*	*Lightest hen*
University Bay	1,600 grams	1,426 grams	1,175 grams	866 grams
Arboretum	1,770	1,342	1,117	927
Faville Grove	1,557	1,886	1,088	879

SUMMARY

Wild pheasants trapped in winter from managed refuges may be cheaper and better than artificial pheasants for replenishing understocked range.

Two hundred and ten such pheasants were trapped, marked, and released under selected conditions in southern Wisconsin during January, 1937.

Where food and cover were good and coverts of ample size, there was no dispersion.

Where food was good but coverts small and scattered, the released birds held well in some instances. In others they (and also the resident birds) adopted a circuit type of ranging similar to that of the large carnivores.

Where food and cover were both poor, dispersion was immediate and complete.

Heavy pre-existing population density did not clearly accelerate dispersal of released birds from good well-fed cover. (Heavy populations in poor or unfed cover do not exist.)

Heavy pre-existing population density further increased by releases seemed to increase the predation rate.

There was no clear topographic orientation in the movement of released birds, but birds released on poor cover within sight of good cover promptly moved to it. Birds released on good upland cover within sight of good lowland cover moved to the lowland.

There were no returns to home range except by accident.

Crop damage near refuges, once started, may continue despite stringent reduction in density of pheasants.

The study disclosed an unexplained difference in weight of pheasants from the two areas trapped.

In general, the Ohio plan is admirably adapted to that transition period in which the farmer, while willing to help feed, is still inclined to let the state worry about winter cover. Under that plan the pheasants are wintered where cover happens to exist and then artificially redistributed so as to stock summer and fall range which would otherwise be vacant. This reduces spring congestion and crop damage. It is an artificial system but less so than the dependence on pen propagation toward which most states are steadily drifting.

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EFFECT UPON WILDLIFE OF SPRAYING FOR CONTROL OF GIPSY MOTHS

Allen Frost

The largest infestation of gipsy moths (*Porthetria dispar*) in New York State during the 1937 season occurred in the Fishskill Mountains in an area abutting and including the western edge of the Clarence Fahnestock Memorial State Park in Putnam County, New York.

Treatment of the area to control the pests offered an opportunity for observations on effects the spraying might have upon the wildlife population.

More than 80,000 egg clusters of gipsy moths were found in the infested area and treated with cresote in 1936, but despite this work many caterpillars were found on the trees this year and spraying was deemed necessary. The area is in the barrier zone where efforts are being made to stop the western spread of the gipsy moth from New England to New York and other states.

Clarence Fahnestock Memorial State Park is in a heavily wooded section of the Fishskill Mountains. The forest is of mixed hardwoods with a few scattered groups of hemlocks and pines. There are occasional small sections that had been previously cleared for farming, but abandoned and now showing considerable underbrush. Elevations vary from approximately 600 feet to 1200 feet. A large part of the park and buffer terrain had been surveyed for the purpose of studying animal life before the spraying was started.

The Eastern States Parkway passes through the park and traverses the western edge of the infested area where spraying took place in 1937. The northerly limit is marked by a county road known as the Bennett Sisters' Road. The eastern boundary of the sprayed area is on the top of the mountain one mile to the east of the Parkway. The southern limits of spraying were near the Fishskill Hollow Road. Woodland swamps and bogs are fairly numerous within the area as well as in all adjacent territory. A 160-acre lake of recent construction and Roaring Brook are within the treated zone. In all, the sprayed area was about 1,500 acres in size.

Six pounds of lead arsenate was used to 150 gallons of water. It was sprayed on ground cover, undergrowth, and the forest canopy by using seven machines over a period of about two months. Each machine was able to distribute 9,000 gallons of the spray in a ten hour day or 15 gallons per minute.

Since it was physically impossible to inspect the entire sprayed area, sample sections were studied that could be compared to others outside the area where control measures were practiced. Observations were made along both sides of the Eastern States Parkway when only the western side was sprayed and along both sides of the Bennett Sisters' Road, where the south side was sprayed. In each case, the type of woods and terrain on both sides of the roads was practically the same, and previous to spraying the bird population on either side of each road was much the same.

Both sides of the Bennett Sisters' Road are heavily wooded with various species of hardwood and occasional pines and hemlocks. The area is characterized by rock ledges and swampy ground. Undergrowth is dense and consists largely of mountain laurel (*Kalmia latifolia*), maple-leaved viburnum (*Viburnum acerifolium*), spicebush (*Benzoin aestivale*), winterberry (*Ilex verticillata*), blackberries (*Rubus* spp.), lowbush blueberries (*Vaccinium* spp.), club moss, and various herbs.

Both sides of the Eastern States Parkway have similar flora; on the east there is a stream known as Roaring Brook and a recently built artificial lake. The type of woods is the same as elsewhere: oak, beech, birch (black, yellow, and gray), tuliptree, ash, and a few scattered hemlocks. On tracts previously cleared, blueberries (*Vaccinium* spp.) were abundant and the mixed shrubbery very dense. The woodland bogs are somewhat larger in extent on the eastern side than on the west, but on the whole the areas are very similar.

A check of sprayed and unsprayed sections showed an abundance of insectivorous birds in the unsprayed, and very few in sprayed, areas. Some of the tracts had to be sprayed heavily during the month of June, the nesting season for most of the birds; and in two cases it is known that the young in the nests were destroyed, not by being fed poisonous insects, but by trampling by persons doing the spraying.

A nest of a chestnut-sided warbler with four dead young was found in the sprayed area and its loss may have been caused by desertion of the parent birds after the spraying. It is not believed that adult birds get a lethal dose of arsenic, but they seem to be driven from the sprayed area. One would suspect it is because of lack of food. When nests were near unsprayed areas, the birds were observed to feed in them and collect food there for the young, flying back to their nests in the sprayed area with the insects. These birds were of species which normally feed within a close radius of their nests, such as the northern yellow-throat, Louisiana waterthrush, veery, and oven-bird. In sections sprayed from two to four weeks earlier, more insectivorous birds were observed in the sprayed places than just after the operation and some were building nests.

On June 17, from 7:30 a.m. to 8:30 p.m., the writer surveyed about 1,000 acres of sprayed territory, a good deal of which had been treated at least two weeks before, and saw only one oven-bird and one veery. In the unsprayed area across the Bennett Sisters' Road many birds were recorded, as noted in accompanying lists.

Records of mammals, reptiles, and amphibians were much more difficult to obtain than those of birds. One dead woodchuck (*Marmota loquax*) was found at the entrance to its burrow and a second was found on the edge of the sprayed area showing symptoms of convulsions and apparently in a dying condition.

Between two and five in the afternoon of June 23, observations were made on a stretch of about 800 feet of Parkway sprayed June 21. A number of snakes were seen coming out of the sprayed area and crossing the road to the unsprayed side. Several were killed by automobiles. Seven blacksnakes

(*Coluber constrictor constrictor*) from three to about five feet long, three garter snakes (*Thamnophis sirtalis sirtalis*) and one hognose snake (*Heterodon contortrix*), were seen in the three-hour period. The writer has studied the fauna and flora of Fahnestock Park over a period of four years, and this observation of so large a number of reptiles in an equal period is the first of its kind. The suggestion brought to mind is that either removal of small rodents or their death due to poisoned vegetation or the killing off of insects upon which some snakes feed were the cause of the migration of these reptiles.

A total of 154 individual birds was recorded on the unsprayed areas during the course of this study and only 18 on the sprayed areas.

OBSERVATIONS AT BENNETT SISTERS' ROAD

June 8, 1937

North side (not sprayed)		*South Side (sprayed)*	
Northern flicker	1	Oven-bird	1
Blue jay	1		
Eastern crow	2		
Northern white-breasted nut-hatch	1		
Veery	3		
Yellow-throated vireo	1		
Black-throated blue warbler	1		
Oven-bird	3		
Northern yellow-throat	1		
	14		1

June 17, 1937

Northern downy woodpecker	2	Veery	1
Blue jay	2	Oven-bird	1
Eastern crow	2		
Black-capped chickadee	2		
Eastern robin	1		
Veery	3		
Red-eyed vireo	2		
Black and white warbler	2		
Black-throated blue warbler	2		
Black-throated green warbler	1		
Oven-bird	6		
Louisiana water-thrush	2		
Northern yellow-throat	1		
Red-eyed towhee	1		
	29		2

June 25, 1937

Eastern crow (with young)	1	Robin	1
Black-capped chickadee	2		
Veery	2		
Black and white warbler (with young)	3		
Black-throated blue warbler	2		
Black-throated green warbler	1		
Oven-bird (and young)	2		
Louisiana water-thrush	1		
Northern yellow-throat	1		
American redstart	2		
Scarlet tanager	1		
	18		1

July 6, 1937

Blue jay	2	Catbird	1
Red-eyed vireo	2	Eastern robin	1
Wood thrush	1	Red-eyed vireo	1
Black and white warbler	5	Black and white warbler	1
Black-throated blue warbler	1	Chestnut-sided warbler	3
Black-throated green warbler	1	Oven-bird	1
Oven-bird	3		
Northern yellow-throat	2		
	17		8

Note: Hot day, birds quiet and difficult to locate.

July 7, 1937

None		Northern crested flycatcher	1
		Black-capped chickadee	1
			2

Note: Very hot day—birds very quiet.

OBSERVATIONS ON SIDES OF EASTERN STATES PARKWAY

June 9, 1937

West Side (not sprayed)		*East Side (sprayed)*
Eastern phoebe	1	None
Northern downy woodpecker	1	
Catbird	1	
Red-eyed vireo	2	
Wood thrush	1	
Veery	2	
Chestnut-sided warbler	2	
Oven-bird	3	
Scarlet tanager	1	
Chipping sparrow	1	
	15	

June 14, 1937

Blue jay	1	Veery	1
Eastern crow	1	Oven-bird	2
Blackcapped chickadee	1		
Catbird	2		
Veery	2		
Red-eyed vireo	1		
Black and white warbler	1		
Chestnut-sided warbler	1		
Oven-bird	4		
Scarlet tanager	1		
	15		3

June 15, 1937

Black-capped chickadee	4	None
Catbird	1	
Wood thrush	1	
Veery	2	
Blue-headed vireo	1	
Black and white warbler	3	
Black-throated green warbler	1	
Oven-bird	1	
Louisiana water-thrush	1	
Northern yellow-throat	1	
Canada warbler	1	
American redstart	2	
Scarlet tanager	1	
	20	

June 21, 1937
(heavy rain)

Veery	1	None
Chestnut-sided warbler	1	
Oven-bird	2	
Red-eyed towhee	1	
	5	

June 25, 1937

Woodpecker (sp.)	1	Eastern crow	1
Catbird (with young)	1	Red-eyed vireo	1
Eastern robin	3	Eastern song sparrow	1
Wood thrush	1		
Veery	3		
Red-eyed vireo	3		
Black and white warbler	3		
Chestnut-sided warbler	3		
Red-eyed towhee	1		
Scarlet tanager	2		
	21		3

Allen Frost
Clarence Fahnestock Memorial State Park
Tompkins Corners, N. Y.

SURVIVAL OF CANADA GOOSE GOSLINGS, BEAR RIVER REFUGE, UTAH, 1937

Cecil S. Williams and William H. Marshall

In a recent study of the nesting of Canada geese on the Bear River Migratory Bird Refuge, Utah,[1] it was found that in 84 nests 331 goslings were successfully hatched, an average of 3.9 birds to a brood. It then became desirable from a management standpoint to discover and evaluate any limiting factors that might influence the gosling population. Accordingly a series of counts both of the number of broods and the number of goslings to a brood was begun on May 2, 1937, when the first brood was observed. The counts were continued until the last day of June, after which it was difficult to distinguish between adult and young birds.

Observations were not restricted to the area on which the nesting study had been made, but were made also on adjacent parts of the refuge, as the broods move freely from one unit of the refuge to another. As little difference in survival on the several units was noted, the data for all have been combined.

The bare earthen dikes that impound the water of the refuge were the preferred roosting places of the geese during the brooding period. Adults with broods moved to these artificial banks every evening soon after sundown and remained there until about 8 o'clock the following morning. The counts were usually made early in the morning from an automobile the progress of which along the dikes caused the birds to move to open water. Field glasses were essential as the birds were usually several hundred yards offshore before all could be counted. Considerable difficulty was encountered at times in obtaining an exact count of the number in a brood because of the effect of wave action and light on visibility. On such occasions, some broods were not recorded.

In all, 2,599 broods were counted, 681 in May, and 1,918 in June. In Table 1, which shows the frequency of occurrence of brood size, it may be noted that a normal distribution was approached during both months. Means were 4.87 and 4.73, repectively, and the standard deviations of 1.8 and 1.4 indicate a close grouping of the data. Coefficients of variation of 3.0 and 3.7 per cent point to a low variability of measurements in each instance. The largest number of broods recorded in one day (June 28) was 186. On that date visibility was excellent, and a count was made on all of the units of the refuge. Thirty-eight of the 46 observation trips were restricted to Units 1, 2, and 3; and the 123 broods recorded there on June 1 probably represent the maximum for these units. It is of interest that the average number of broods seen per trip around the area was 84.4, this being 68 per cent of the above maximum. On only four occa-

[1] Williams, C. S., and Wm. H. Marshall, Goose nesting studies on the Bear River Migratory Waterfowl Refuge, Utah. JOURN. WILDLIFE MANAGEMENT, vol. 1, nos. 3–4, October 1937, pp. 77–86, Pls. 6–8, 4 figs., 1 table.

sions did the count exceed 85 per cent of the maximum. These percentages are worthy of note because they were obtained on an area where a daily habit of the birds made possible a definite census method that could approach a complete sample.

TABLE 1
FREQUENCY OF OCCURRENCE OF CANADA GOOSE BROOD SIZES

Size class	*May*	*June*
1	13	74
2	86	228
3	116	340
4	129	405
5	130	325
6	80	199
7	42	131
8	22	68
9	28	56
10	10	24
11	6	27
12	9	15
13	4	5
14	3	7
15	3	2
16	—	4
17	—	2
18	—	2
19	—	2
20	—	1
26	—	1
Totals	681	1,918

It will be noted that there is a difference between the average size of brood for May and the average size of broods found to have left the nest during the nesting study. The increase is caused by the banding together of two or more broods under the care of one pair of adults as the birds move from the dikes to open water. Such shifts were frequently noted and were accompanied by frenzied calling and flying about of the adults losing their broods. The largest number of goslings seen together was 26, probably representing at least six normal broods.

The loss of one-tenth of a gosling per brood as is indicated by the means for May and June is within the limits of observational error. It may, however, approximate the true loss. Certainly there were no outstanding destructive factors. During the study, one authentic report was received of a California gull taking a gosling. The adult geese made no attempt to protect the young in this instance, and the gosling's efforts to escape the gull by diving were unsuccessful. On many occasions California gulls were observed resting on dikes among the goose broods during the early mornings and feeding in areas adjacent to them later in the day. The gulls were the only diurnal predators that could reach the broods. Six dead goslings were found during the study but could not be satisfactorily autopsied because of decay.

The habits of the geese during the period were of considerable interest. Their roosting on the dikes at night, the mixing of broods, and the methods of escape from unknown danger and gulls have been mentioned. There was a very definite grouping of broods throughout the period of study. At least 75 per cent of the broods in Unit 2 could be found daily at three localities along the outer dikes. There was no apparent environmental reason for this, as the dike is quite uniform in character and the localities represented extremes as to distance from the vegetation of the unit. The birds when disturbed from their roosting places on the dike would always swim in the direction that would ultimately place them farthest from the observer when he arrived at the spot they had left. This often involved swimming slightly toward the approaching car.

SUMMARY

1. The growth rate of wild Canada goose goslings is such that it is difficult to distinguish them from adults in the field two months after they leave the nest.

2. A definite requirement for a dry roosting place was noted.

3. Counts of 2,599 broods were made. These indicated an average brood size of 4.87 and 4.73 for May and June, respectively, these means being based on approximately 70 per cent of the broods.

4. Banding together of broods was frequently observed.

5. Mortality factors were found to be negligible.

6. A grouping of broods on certain parts of the outer dike indicated a social instinct.

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RESULTS OF THE CLARK NATIONAL FOREST FUR-BEARER SURVEY

Earl L. Atwood, Jr.

The Clark National Forest comprises slightly less than 2,000,000 acres gross area in the Ozark portion of Southeast Missouri. It is one of the newer forests, having first been established as a purchase unit in 1934 and enlarged to its present size in March 1935.

Prior to the making of the survey, here reported upon, it has been the practice on this forest to prepare the fur-bearer section of the Supervisor's annual wildlife report from statements received from rangers. Estimates of the fall populations and of the number of animals removed by trapping were included but after checking over these reports for two seasons it became apparent that the true picture was not being presented.

It was decided, therefore, to make a forest-wide inquiry among the trappers and fur buyers and on February 1, 1937 the first steps were taken to initiate this survey. All rangers were requested to assign a qualified man to secure from the trappers on each ranger district the following information:

1. Name and address of each trapper, number of pelts collected by him, and average price received; also a statement as to the per cent of decrease or increase for each species during the past five years; the number of seed stock of each species remaining in each trapping territory at the close of the 1936–37 trapping season; and the size and location of the individual's trapping territory for each species.

2. Map: (a) Showing location of residence of each trapper by a system of numbers; and (b) The range of each trapper's operations.

This survey was conducted during the month of February by one man on each ranger district. The personnel used consisted of refuge keepers and CCC camp foremen thoroughly familiar with the district and fairly well known to the inhabitants.

Difficulties were encountered in each district which reduced the quantitative value of the survey, but which also brought to light a condition, the extent and seriousness of which has, no doubt, been overlooked by State authorities. In interviewing the trappers it was found that some were loath to give information concerning their catch because they had trapped without a license and many refused to give the information for this reason. The percentage of trappers in this category varied between ranger districts but was high in all parts of the Forest. It was impossible to determine accurately what this proportion averages for the Forest, but estimates were from 20% to 50% for different districts. From conversation with the men who made these surveys and with fur buyers, it is believed the average percentage was in the neighborhood of 40%. Most of the trappers who spend a considerable portion of their time at trapping each season buy a license. Many of the farmers, farm boys and others, however, who trap incidentally to their regular work, do not purchase a license.

It was extremely difficult to obtain information as to the amount of seed stock in point of numbers left of each species at the end of the trapping season. It was not difficult, however, to obtain statements from well-informed trappers and fur hunters as to the relative abundance of seed stocks. Statements of trappers indicated that the relative abundance of seed stock at the end of the season on the basis of maintaining the population levels of last season (in the order of decreasing abundance) was: gray fox, wolf, red fox, wildcat, skunk, opossum, raccoon, muskrat, and mink.

It was found to be universal with the trappers to attempt to capture every mink, muskrat, raccoon, opossum, and skunk within their trapping territories. Attempts to obtain the pelts of wolf, gray fox, red fox, and wildcat were made much less often in proportion to the attempts on the former group. This is explained by the fact that during the time necessary to trap gray fox or wildcat, the average trapper could be getting several opossums, skunks, muskrats, or possibly raccoons which would be worth more than the gray fox or wildcat. But while the red fox pelt follows the mink in point of value and the wolf pelt follows the raccoon, there are relatively few trappers with the ability to make more money trapping these animals than those in the first-named group. By comparing the weighted average furbearer population trend (Table 1) with the relative abundance of seed stock remaining at the close of last season on the basis of maintaining pretrapping numbers, we find that those species with the least seed stock remaining at the end of the last trapping season have also shown the greatest decrease during the past five years and those species with the greatest relative seed stock left at the end of the 1936–37 trapping season have maintained population levels or increased during this period. For example, compare the gray fox population trend during the past five years with the reported seed stock remaining at the end of the 1936–37 trapping season (as shown in Table 1), with the trend of the mink population which as indicated by trappers decreased

TABLE 1
1936–37 SEASON DATA AS TO TAKE BY CLARK FOREST TRAPPERS

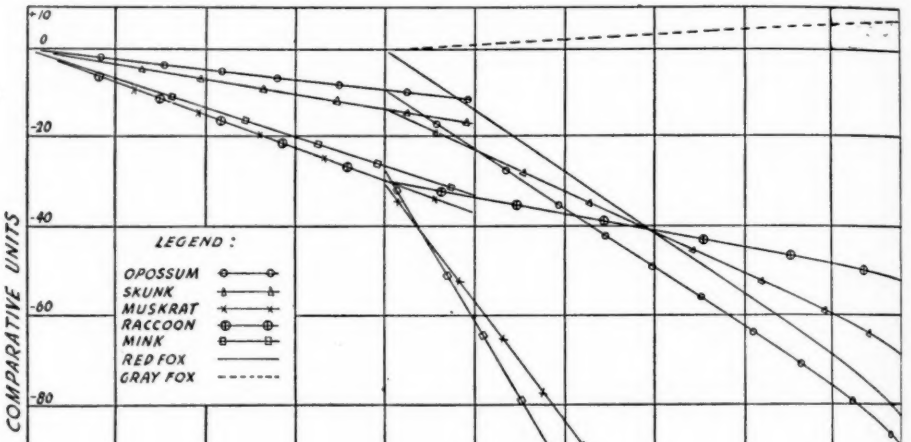
	Species Trapped									
	Opossum	Skunk	Muskrat	Raccoon	Mink	Red Fox	Gray Fox	Wolf	Wildcat	Weasel
Number of pelts from area surveyed	4,234	564	563	258	83	55	102	40	21	4
Average price received by trapper	$.30	$1.00	$1.00	$3.75	$6.59	$4.26	$1.60	$2.88	$1.25	$.88
Percentage of total number	71.5	9.6	9.5	4.4	1.4	0.9	1.7	0.5	0.3	Trace
Percentage of total value	28.7	12.7	12.7	21.8	12.3	5.2	3.7	2.6	0.6	Trace
Weighted average population change over past 5 years	−5.5%	−3.5%	−13.2%	−6.4%	−20.9%	−1.7%	−3.7%	[1]	[1]	[1]

[1] Insufficient data to give reliable figures.

20.9% and which had practically no seed stock remaining at the close of the 1936–37 season.

POPULATION TRENDS

As has been indicated earlier, the attempt was made during the survey to have the trapper or fur buyer give a statement as to the trend on a percentage basis for those species with



Graph 1. Population trends of fur animals: 1924–34, Missouri; 1932–36, Clark Forest; 1937–44, projected.

which he was familiar. There are three possibilities: the population is increasing, decreasing, or remaining the same. An arithmetical average of change does not give the true picture of population trend, since reports that the trend had been to remain the same would be eliminated without exerting any effect on the average. However, the following method of evaluating the three variables allows each one to exert an equal effect: If the replies for each species are converted to a percentage basis the difference between the largest and next largest percentage will represent the force of trend. This is but a short cut to the final figure obtained by subtracting the smallest force from each of the two larger forces and then taking the difference between the remaining two forces. For instance, the results of the replies as to the trend for opossum showed that 64% believed the population to be decreasing, 7% believed it the same, and 29% believed it increasing. We eliminate the 7% by subtracting it from 29% and from 64%, leaving 57% claiming a decrease and 22% claiming an increase. Then we take the difference between these two and get the remainder 35 which can be plotted as a graph to indicate population trend (Table 5 and Graph 1).

Explanation of graphs of furbearer population trends: In Graph 1, the data in Table 5 are presented by plotting the trend of the survey made by Bennitt and Nagel (1) for the period

TABLE 2

TABLE 2
FUR-BEARER POPULATION TRENDS DURING PERIOD 1932-36, INCLUSIVE, ACCORDING TO OPINIONS OF QUALIFIED TRAPPERS

Opossum			Skunk			Muskrat			Raccoon			Mink			Red Fox			Gray Fox			Wolf*			Wild Cat*			Weasel*		
+	–	NC	+	–	NC	+	–	NC	+	–	NC	+	–	NC	+	–	NC	+	–	NC	+	–	NC	+	–	NC	+	–	NC
46	102	11	22	47	14	3	32	1	20	46	6	0	21	1	7	13	3	13	12	9									
29%	64%	7%	26%	57%	17%	8%	89%	3%	28%	64%	8%	0%	96%	4%	30%	57%	13%	38%	35%	27%									

* No data from fur buyers.

TABLE 3
FUR-BEARER POPULATION TRENDS IN SOUTHERN MISSOURI 1924-34
(FROM BENNITT & NAGEL'S SURVEY OF 1934)

Opossum			Skunk			Muskrat			Civet			Raccoon			Mink			Red Fox			Weasel			Gray Fox		
+	–	S	+	–	S	+	–	S	+	–	S	+	–	S	+	–	S	+	–	S	+	–	S	+	–	S
22	118	95	45	110	72	13	134	61	13	63	52	22	145	62	12	130	63	69	50	72	10	76	70	54	43	41
9%	51%	40%	20%	48%	32%	6%	65%	29%	11%	45%	44%	10%	63%	27%	6%	63%	31%	36%	26%	38%	6%	49%	45%	39%	31%	30%

TABLE 4
FUR-BEARER POPULATION TRENDS DURING THE PAST 5 YEARS ACCORDING TO PERCENTAGE OF OPINIONS OF FUR BUYERS IN AND ADJACENT TO CLARK NATIONAL FOREST

Opossum	Skunk	Muskrat	Raccoon	Mink	Red Fox	Gray Fox	Wolf	Wild Cat	Weasel
–35%	*	–50%	–50%	–30%	–26%	No change	*	No change	*

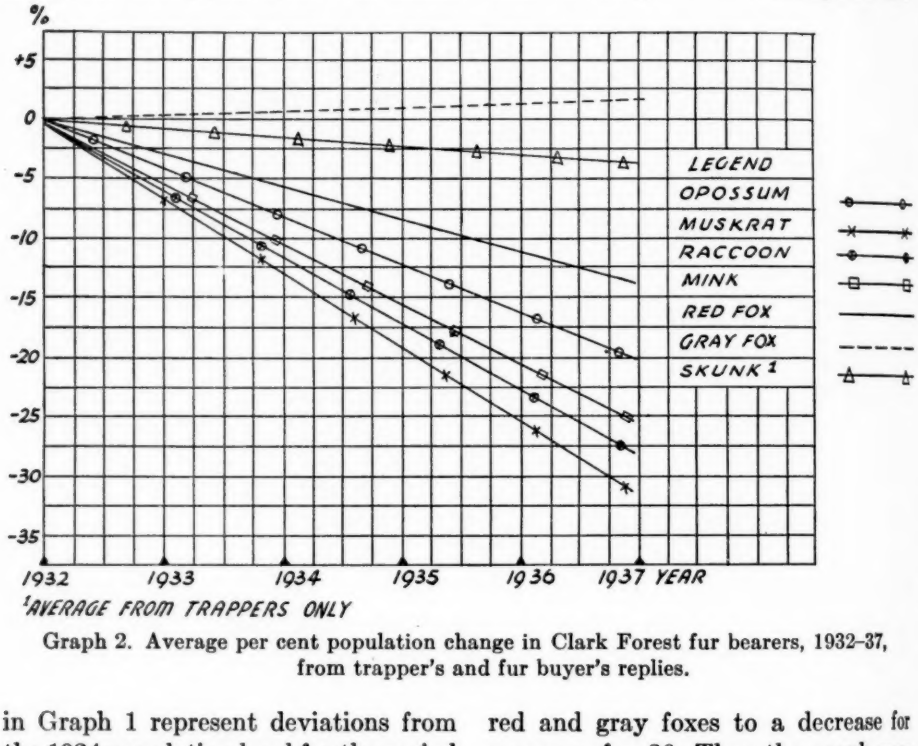
* Insufficient data from fur buyers to give representative figures.

TABLE 5
SUMMARY

Trends	Opossum	Skunk	Muskrat	Raccoon	Mink	Red Fox	Gray Fox
(1) 1924-34	–11	–16	–36	–36	–32	(2) Same	(9) Same
(2) 1932-36	–35	–31	–81	–36	–92	–27	+3

1924–34 and of the Forest Service survey for the period 1932–36.

The horizontal axis is used to represent the 1924 level and vertical distances above or below this represent deviations from this level. Time in years is represented by equal distances along the horizontal axis. The slants



Graph 2. Average per cent population change in Clark Forest fur bearers, 1932–37, from trapper's and fur buyer's replies.

in Graph 1 represent deviations from the 1924 population level for the period 1924–34 from the Bennitt and Nagel data, the 1932–36 trend from the Forest Service data assuming the population had deviated to the level of 1932 as shown by Bennitt and Nagel, and the future trend 1936–42 if present controlling factors remain unchanged.

Graph 2 is the plotted change in furbearer populations on Clark Forest from the 1932 level to the end of the 1936–37 season expressed in per cent from the average of replies from trappers and fur buyers.

INTERPRETATION OF GRAPH OF FURBEARER POPULATION TRENDS

A glance at the graph (1) for the years 1924–34 shows the population trend to vary from no change for the red and gray foxes to a decrease for raccoon of −36. Thus the graph may be interpreted to indicate relative decreases which for purposes of further comparison may be assigned values indicated on the graph for the year 1934. The fox population trend has been to remain the same as for 1934, the opossum numbers decreased to about −7.4, the skunk to −10.7, the mink to −21.4, and the muskrat and raccoon to −24.2. It has been known by trappers, fur buyers and others interested in

wildlife that the fur bearers in general have been decreasing for many years, but this is the first attempt to portray graphically the relative rates of the downward trend.

CONCLUSIONS AS TO TREND 1924–34

1. Red and gray fox numbers remaining stationary.
2. All other fur bearers decreasing.
3. Rate of decrease for mink, muskrat and raccoon was approximately three times that of skunk and opossum which were serious.

TRENDS DURING 1932–36

Since the Forest Service survey for the 5 years was, in a general way similar to the Bennitt-Nagel survey for the period, it is logical to assume that our data can be used to extend the graph from the values indicated for 1932 to the values obtained for 1936–37 season to indicate change in trend during the five-year period. The trend as shown on the graph has been toward a continued, and progressive reduction in numbers, except for gray foxes which show a slight increase.

The change of individual species was as follows:

	%	%
opossum from	− 9 to	−35
skunk from	−13 to	−31
muskrat from	−29 to	−81
mink from	−26 to	−92
raccoon from	−29 to	−36
red fox from	0 to	−27
gray fox from	0 to	+ 3

TRENDS OF WOLF AND WILDCAT POPULATION

The interviews with fur hunters and trappers did not yield a great deal of information concerning the trends of wolf and wildcat populations in the Clark Forest. To obtain this information, professional trappers were consulted and they believe that there has been a gradual general decrease in the number of wildcats during the past twenty years. This supports the findings of Bennitt and Nagel in their survey of 1934. During the period 1935–37 the number of wildcats has decreased at a faster rate in most portions of the Clark Forest, the exceptions being in Oregon County adjacent to the Eleven Points River in the vicinity known as Irish Wilderness and in the Forest Service-State Cooperative Eleven Points Refuge. In these two areas there has been an increase in wildcats during the past five years. During this period there has been an exodus of settlers with the result that the wildcats and wolves have suffered less than formerly.

The trend in wolf population in the Clark Forest during the past five years has been generally upward. Stockmen's associations and wolf trappers are agreed upon this fact. Apparently certain areas have offered habitats more suitable than others and in these areas the increase has been more rapid. The following counties within the Forest boundaries have shown an increase: Iron, Dent, Reynolds, Crawford, Washington, Oregon, Ripley, and Madison. In the remaining counties the population has remained about stationary.

One trapper in Madison County has kept an accurate record of the wolves he has trapped or shot during the past twenty years. During this period he has trapped over the same area and by the same methods, hence it is believed that the record (here reproduced) reflects

the wolf population trend for the Clark Forest in general and for Madison County particularly.

A Madison County wolf trapper's record 1918–37:

1918—6	1923—0	1928—9	1933—2
1919—5	1924—5	1929—0	1934—7
1920—7	1925—0	1930—1	1935—0
1921—0	1926—0	1931—0	1936—12
1922—0	1927—4	1932—0	1937—12

These figures indicate that the wolf population in Madison County is as great or greater than at any time during the past twenty years. During 1935 Madison County paid bounties for five adults and 13 young wolves. The increase since 1934 may be explained in part by improvement in cover resulting from the sprouting of undergrowth as a result of fire protection in the Clark Forest during 1934–36. Another factor has been the exodus of residents from large blocks of land acquired by the Forest Service with the result that a considerable number of areas have been created where the wolves have remained unmolested during this period. Other contributing factors are the cessation of payment of bounties by many counties financially embarrassed, and the greater time necessary to trap wolves, leaving too little incentive to trap the animals when no bounty is offered.

SUMMARY

1. All fur bearers in the Clark National Forest, with the exception of wolf and gray fox, have shown a sharp decrease in numbers from 1932 to 1937.

2. The decrease in muskrat, mink, and raccoon during this period has been so rapid that all indications point to their being extirpated within a very few years if present decimating factors continue.

3. The decrease in skunk and opossum during the 1932–37 period has been much more rapid than during the 1924–32 period, indicating that these fur bearers have been reduced to the point where the numbers will decrease at an increasing rate which may result in five years, in their being in the present plight of the mink and muskrat, if present trends continue.

4. The red fox and wildcat has shown a slight decrease in numbers during 1932–36, though they can still be classed as common.

5. Wolves and gray foxes have shown a slight increase since 1932. Available information indicates there are more of these animals than at any time during the past twenty years.

6. At present, the opossum is the most important in point of total numbers trapped and in total value of the pelts.

7. The 300 trappers and fur buyers interviewed are about half of the total number operating.

8. The size of the individual trapper's range varied from 300 to 12,000 acres with an average of about 700 acres.

9. The most heavily trapped areas were bottom lands along streams with an average of approximately ½ mile of stream per trapper.

LITERATURE CITED

1. BENNITT, RUDOLF, and NAGEL, W. O. 1934. A survey of the Resident Game and Furbearers of Missouri. The University of Missouri Studies, Vol. XII, No. 2.

Earl L. Atwood, Jr.
U.S. Forest Service
St. Louis, Missouri

NOTES

As a result of the recently completed mail balloting, it is announced that the Regional Representatives have all been reelected. See list on outside back cover.

The President states that he has appointed Dr. Ralph E. Yeatter of Champaign, Illinois, as Chairman of the Nominating Committee for the coming meeting of The Wildlife Society.

The North American Wildlife Conference will be held in Baltimore, Maryland, with headquarters at the Lord Baltimore Hotel, February 14–19, inclusive, 1938. Wildlife Society meetings have been scheduled as follows: Meeting of the Council 2:00 P.M., Sunday, February 13; annual business meeting 7:30 P.M., Monday, February 14; and a social gathering 7:30 P.M., Tuesday, February 15, preceding which any business not completed at the previous meetings will be disposed of. During the course of the social meeting, refreshments will be served.

Since the only opportunity to act upon all applications for membership and bring the work of the Membership Committee up-to-date will be at the annual meeting, publication of a formal printed list of members will be deferred until the April issue of The Journal of Wildlife Management. A mimeographed list of members, as complete as circumstances will permit, will be available, however, at the meeting and copies of it can be obtained by members not attending the meeting upon request to the Secretary, Victor H. Cahalane, National Park Service, Washington, D. C.

EMPLOYMENT SERVICE OF THE WILDLIFE SOCIETY

Purpose: This service will be operated as a department of the Journal for the dual purpose of publishing information concerning (1), available positions and (2), qualifications of persons seeking such positions.

Limitations: To conserve the time of officers, the Employment Service will be confined to announcements of openings and statements of the qualifications of candidates. All correspondence will be between prospective employers and applicants, and not with officers of the Society. Appointments to nearly all federal and many state positions in wildlife management are based upon Civil Service ratings. Aspirants should therefore apply to the U. S. Civil Service Commission, Washington, D. C., or to corresponding state organizations for announcements of examinations. Appointing officers are invited to report vacancies and new positions to the Employment Service.

Procedure: Each member will be entitled to one five-line statement of his education, qualifications, and preferences as to type of position in each volume. Additional lines will be charged for at the rate of 5 cents per line, and additional insertions at the same rate for all lines required.

All communications for the Employment Service should be sent to the Editor, W. L. McAtee, Bureau of Biological Survey, U. S. Dept. of Agriculture, Washington, D. C.

DEPUY, PERCY L., 1725 Leavenworth, Manhattan, Kansas. M.S. Kansas State College, 8 years on Kansas State faculty, 3 years with U.S. Biological Survey, 1 year as Assistant Biologist with Soil Conservation Service. Last position terminated for lack of funds. Desire position in teaching, research or practical wildlife management.

HAHN, PALMER L., 301 So. Walnut Street, Milford, Delaware. New York State College, of Forestry, 1925. Employed more than 2 years as Chief Forester and Wildlife Technician with Farm Security Administration in Delaware; desires position with any wildlife program. Present position terminated by lack of funds!

SCHROEDL, JOHN F., 5027-29th Avenue S., Minneapolis, Minnesota. B.S. University of Minnesota, 1937. Major wildlife management; minor forestry. Position desired: field work in wildlife management.

SMITH, J. ROBT., 401 E. Third Street, Superior, Wisconsin. B.S. University of Minnesota. 1937. Graduated with major in wildlife management and minor in forestry. Employment desired in any wildlife work.

STILES, CHARLES A., 120 Chestnut Street, Fairhaven, Massachusetts. Two years college training. Four and a half years foreman in CCC work, including past year and a half in charge of wildlife work on 5,000 acre refuge. Field work desired.

THE JOURNAL OF WILDLIFE MANAGEMENT

VOLUME 2 APRIL 1938 NUMBER 2

DUCK NESTING STUDIES, BEAR RIVER MIGRATORY BIRD REFUGE, UTAH, 1937

Cecil S. Williams and Wm. H. Marshall

The reservation of marsh, lake, and pond areas where waterfowl once nested in great numbers or where they paused to rest in their seasonal migrations has done much to insure the continued existence of many species. Such areas must, however, be managed to provide adequate food, cover, and protection not only for birds already frequenting them, but also for the increased numbers which may be expected in the future. A thorough understanding of the habits and requirements of the waterfowl and of environmental forces acting upon them is necessary if such areas are to be managed to the best advantage for the purposes for which they were created.

During the summer of 1937 investigations were made at the Bear River Migratory Bird Refuge to obtain data concerning the nesting requirements of waterfowl there, the factors influencing nesting, and how conditions might be improved. Findings relative to the Canada goose were presented in a previous paper (1), while those pertaining to the various species of wild ducks are given in the present report.

Acknowledgments are made to Vanez T. Wilson, Refuge Superintendent, for the use of a boat and motor, which were essential to the work. The writers are indebted also to Douglas Jones, Utah State Agricultural College student, and to William Cawley, Mitchell Shostak, and Robert Gabbert, CCC enrollees, who assisted in the field work.

THE BEAR RIVER REFUGE

The extensive marches of the Bear River delta, located near the northeastern end of the Great Salt Lake in Utah, have been known for many years as one of the more important waterfowl areas in the West. Accounts of early explorers tell of millions of birds, and as Utah became settled, market hunters and later hunting clubs were established here. In more recent years the extent of the area valuable to waterfowl has been considerably reduced by changing climatic conditions and by intensive use of the Bear River for irrigation and power purposes. Fewer birds have frequented the area, and of those, many thousands have succumbed to botulism.

In 1928 Congress authorized the establishment of the Bear River Migratory Bird Refuge, and in 1929 construction of earthen dikes to impound the fresh water of the Bear River and to exclude the saline water of Great Salt Lake began. About twenty-five miles of dikes now divide the refuge into five units and enclose approximately 25,000 acres of shallow water. (Fig. 1.) Diver-

sion of water into the several units is by means of both artificial and natural channels and the water levels are regulated by means of spillboxes in the dikes and of control gates on the river itself. At the present time the main flow of the river enters Unit II of the Refuge

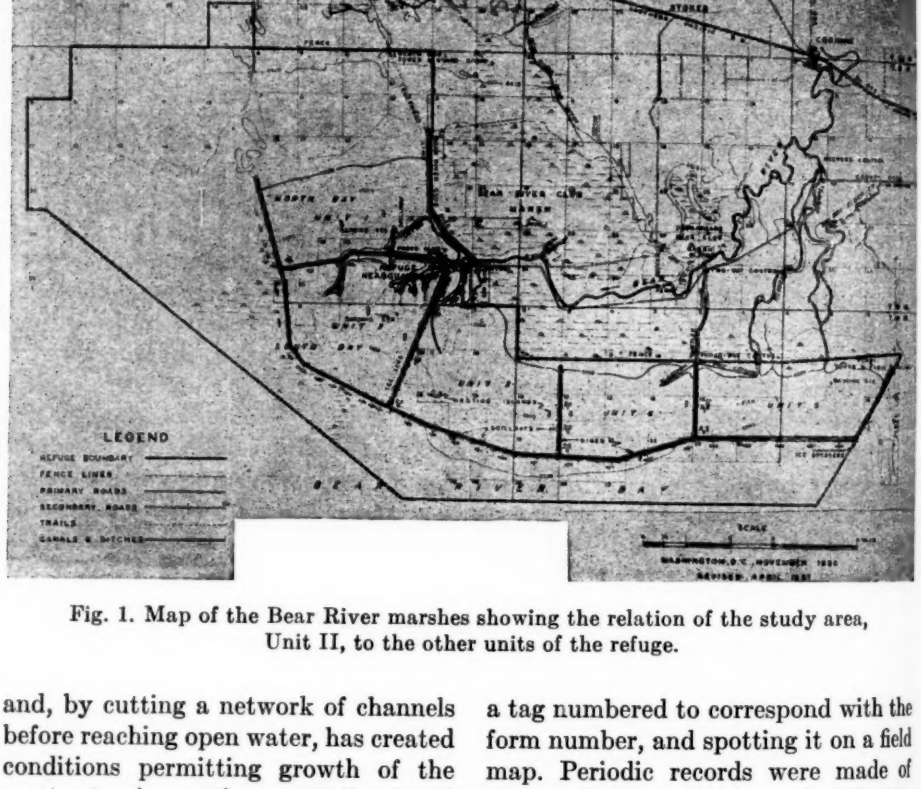


Fig. 1. Map of the Bear River marshes showing the relation of the study area, Unit II, to the other units of the refuge.

and, by cutting a network of channels before reaching open water, has created conditions permitting growth of the most extensive nesting vegetation found on the refuge. The studies here reported relate to this Unit.

METHODS OF THE INVESTIGATION

The methods used were quite similar to those reported (1) for the Canada goose study and need be only briefly outlined here. They consisted of periodically and methodically searching the entire area for nests, recording the desired data on field forms, a sample of which was reproduced in the previous report (1, p. 80), marking the nest with a tag numbered to correspond with the form number, and spotting it on a field map. Periodic records were made of changes in water levels, and of the history of the clutches of eggs. Care was taken to cover the eggs with nesting material promptly after counting them. The following standards were adhered to as closely as possible in recording the history of nests: eggs were recorded as

hatched only if egg membranes bore evidence of that fact; as destroyed by predators, where absent or if fragments of shell or yolk were found in the nest; as flooded, when the eggs were found in the water or indications were that the nest had been under water; and as deserted, when they were found cold on several occasions and there was no evidence that a bird was attending the nest. Instances occurred where eggs had evidently been pushed out of nests by sitting birds; the category of miscellaneous failures included also eggs that were not hatched due to the death of the female on the nest, as well as young birds that died in the nest or eggs. In all other cases eggs were listed as Not Hatched—cause unknown; this recording included infertile eggs and also eggs of community nests which failed to hatch. The fate of 65% of the located nests was determined with an average of 2.3 visits per nest.

THE NESTING SEASON

The 1937 nesting season for ducks on the Bear River Refuge began the first week in May, reached its peak during the last part of June, and terminated during mid-August. As shown in Figure 2, indicating the number of nests of the four major species found during each ten-day period of study, nest building activity was at its height by mid-June and the greater part of the birds were incubating by the last of that month. Although hatching of mallard eggs was noted in May, apparently the hatching peak for the four more common species was not reached until about the twentieth of July, hatching being still low at the first of the month. At the time the nesting study was closed on August 6, there were still a few females incubating eggs.

THE NESTING POPULATION

Many species of birds nest on the refuge and due consideration should be given to all in any management measures undertaken. Included among the

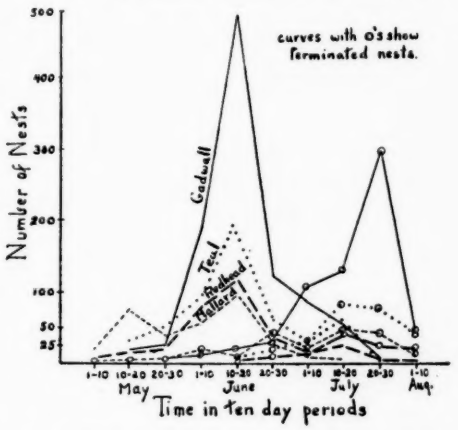


Fig. 2. Trends in number of nests of the four principal species found and terminated during each ten day period of the study.

breeders are such interesting and valuable species as the Canada goose, coot, marsh wren, avocet, willet, black-necked stilt, Franklin and California gulls, western and pied-billed grebes, Brewster's egret, glossy ibis, Forsters and black terns, Treganza's and black-crowned night herons, and the double-crested cormorant. This report deals with only the duck nesting populations.

Nests of nine species of ducks were found in the study area, that of the gadwall most abundantly, 928 nests of this species being located, representing 39% of the total. Nests of the other ducks were found in the following numbers and percentages: cinnamon teal, 524, 22%; redhead, 343, 14%; mallard,

312, 13%; pintail, 209, 9%; ruddy, 50, 2%; shoveller, 37, 1%; and bluewinged teal and widgeon, four nests each. Thus a total of 2,410 nests was found. A careful field check with the refuge staff indicated that this number probably represented 80% of the nests on the

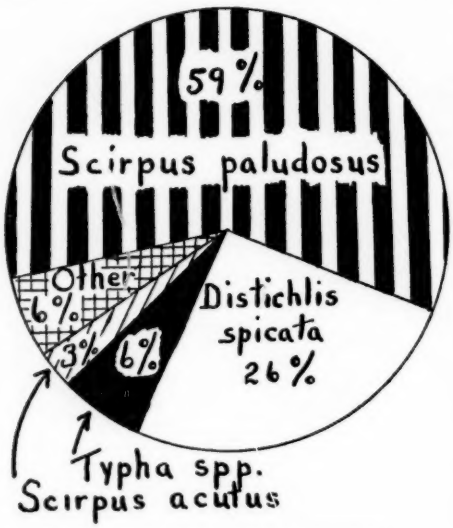


Fig. 3. Cover types by percentages of area in Unit II.

area, and that there was a total population of about 3,000 pairs on the unit.

LOCATIONS OF NESTS

The location of the nests of the several species is noted on the species nest maps (Plates 2–4 in the appendix). With the exception of those of the ruddy and redhead ducks, the nests were mostly in the upstream parts of the marsh. The nests of even the redhead tend to be centered away from the lower marsh area. The general grouping of the nests apparently reflects preferences for certain types of cover and the influence of certain environmental factors to be discussed later.

DISTRIBUTION OF SUITABLE NESTING COVER

The factors which influence the kind and distribution of the marsh plants on the refuge are as yet imperfectly understood, but preliminary investigations indicate that the courses of channels and soil alkalinity play major roles. The vegetation map (Plate 2-A) shows the general location of the main species of cover plants occurring in the Unit, and the percentages of the total area that each occupies are indicated in Figure 3. In order to analyze plant distribution further, transects were run on representative lines across the upper and lower parts of the marsh. In Plate 1, the upper drawing illustrates vegetative conditions at the higher levels of the marsh while the lower drawing represents those of the lower levels.

In the upper marsh there is a zonation of cover that is apparently dependent on channel water, ground elevation, soil moisture, and soil alkalinity. Hardstem bulrush (*Scirpus acutus*), the width of whose zone varies inversely with the elevation and slope of the channel banks, with an occasional patch of cat-tails (*Typha latifolia* and *T. angustifolia*) usually occupies the strip nearest the channel. The next zone may be of willow, of a mixed community of weeds, or of both. This zone is seldom more than twenty-five feet in width for it normally occupies only the better drained ground. A shallow area, barren of vegetation, the extent of which is apparently correlated with the concentrations of soluble salts that drain off the elevated channel-banks and accumulate in the depressions, is commonly found about equidistant between the channels. Between this and the willow-

weed zone are found glasswort (*Salicornia rubra*) and salt grass (*Distichlis spicata*) with the former, apparently more tolerant of salts, bordering the barren area.

The vegetation of the lower marsh is quite different; most of the area is covered with water, in which alkali bulrush (*Scirpus paludosus*) is dominant, and large patches of cane (*Phragmites communis*), hardstem bulrush, and cattails occur. Shallow ponds or barren areas are found interspersed among the vegetation. Saltgrass grows only on slight elevations that are never entirely covered with water. On artificial banks a few alkali-tolerant plants such as *Atriplex hastata* and *Chenopodium* spp. grow while some saltgrass occurs in sod transplants.

COVER TYPES AND THEIR USE

Each of the zones of vegetation in the upper marsh as well as the extensive areas of emergents of the lower areas both require and create conditions which apparently determine their utilization by nesting ducks. The use made of the several nesting environments was determined by recording the number of nests found in each and will be considered in some detail since it seems to indicate cover preferences on the part of the duck species.

The number of nests for each duck species as well as the percentage located

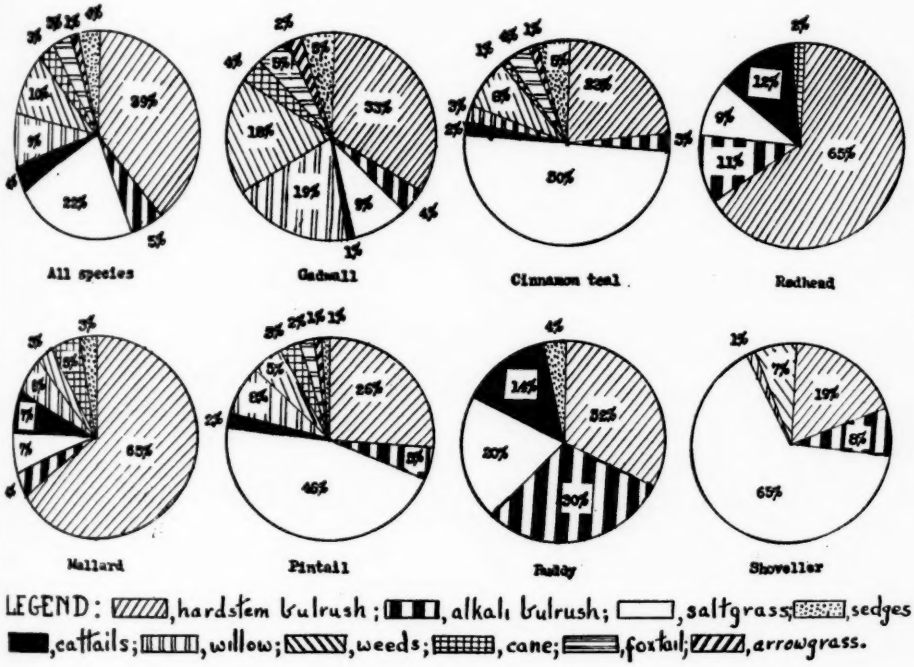


Fig. 4. Charts showing the use made of cover types for nesting by ducks as a group and by individual species.

in each type of cover are noted in tables in the appendix. This information is also graphically condensed in Figure 4. It is apparent that the plant communities on the Bear River Refuge differ considerably in their value as nesting cover. This is true whether ducks be treated as a group or as individual species. Since the service rendered by a certain cover is conditioned to a great extent by the amount available, per cent acreage-use ratios,

$$\frac{\text{(per cent of nests in a cover)}}{\text{(per cent acreage of a cover)}},$$

were determined for each type of cover by species of ducks, and compiled in Table 1. To each of the six kinds of cover which singly constitute less than 1% of the vegetation but in aggregate total 4%, an arbitrary acreage value of .66% was given. In the case of saltgrass the available nesting area in which was reduced at least 50% by flooding, the acreage value is halved, thus 13 instead of 26 is used. These per cent acreage-use ratios serve for comparing the use made of one cover type by the various ducks, and also the values of all cover types to each species of duck.

Hardstem bulrush comprises 3% of the vegetation of Unit II and is found both bordering the upper channels and as patches in the lower marsh. Its height varies considerably, in favorable places being ten feet, while in drier spots it may not exceed one foot. The density averages about 1.5 culms per linear foot. During the winter the culms of the season bend in various directions producing a ground cover *beneath* which ducks find suitable nesting sites. The Canada geese were reported (1, p. 83), as utilizing this plant as a base *upon* which to build their nests, but the ducks were found to use it only for concealing cover or nesting material.

Cover of hardstem bulrush was extensively used by all duck species. Of all the nests found, 39% were in it; and, as regards its use by species, only for the cinnamon teal and the shoveller did the percentage fall below 25, being 23 and 19 for these species, respectively. The redhead and the mallard ducks made the greatest use of this type, each having 65% of their nests therein, ap-

TABLE 1
PER CENT-ACREAGE USE VALUES

Covertype	Gadwell	Cinnamon Teal	Redhead	Mallard	Pintail	Ruddy	Shoveller	All Species
Hardstem bulrush	11.0	7.6	21.6	21.6	8.6	10.6	6.3	13.0
Alkali bulrush	.1	.1	.2	.1	.1	.5	.1	.08
Saltgrass	.7	3.8	.7	.5	3.6	1.5	5.0	1.7
Cat-tail	.2	.3	2.3	1.1	.3	2.3	—	.7
Willow	28.7	4.5	—	9.0	12.0	—	1.5	13.5
Weeds	27.1	12.0	—	4.5	7.61	—	10.5	15.5
Cane	6.0	1.5	3.0	7.6	4.5	—	—	4.5
Foxtail barley	7.6	6.0	—	—	3.0	—	—	4.5
Arrowgrass	3.0	1.5	—	—	1.5	—	—	1.5
Sedges	7.6	7.6	—	4.4	1.5	6.0	—	6.0

proximately double that for the gadwall and ruddy, while the pintail had 26%. If per cent utilization of a cover be an index to the degree it meets nesting requirements, and the lowest utilization be taken as 1 (the shovellers' 19%, in this instance), the relative value of hardstem bulrush might be appraised for: redhead and mallard, 3; gadwall and ruddy, 2; and cinnamon teal, pintail, and shoveller, 1.

Alkali bulrush constitutes 59% of the marsh vegetation in Unit II and is located predominantly in the lower part. This perennial emergent grows well in subalkaline soil that is covered with a few inches to a foot of water, though it does occur in shorter and less dense stands on areas that are periodically flooded. Its density is about the same as that of hardstem bulrush, but its height averages about 28 inches as compared to as much as six feet for the other bulrush. The dry culms that remain each winter seldom form a foundation above the water; consequently, nests placed in this cover must be built up around adjacent supporting culms of the previous season's growth or upon the foundation below the water. In either case, the nearby vegetation is used for nesting materials and the nest is poorly concealed.

A total of 134 nests, representing 5% of all the nests located were found in alkali bulrush. This cover was used chiefly by the ruddy and redhead ducks, species which often make foundations for their nests. It was noted that all of the duck nests other than those of the redhead and ruddy in this cover, were at the border of other vegetation where the mud was not covered by water. Nests in alkali bulrush were distributed as follows among the duck species: ruddy, 15 nests, 30%; redhead, 7, 11%; shoveller, 3, 8%; pintail, 10, 5%; gadwall, 39, 4%; mallard, 12, 4%, and cinnamon teal, 18, 3%. The comparative estimate of the value of alkali bulrush for the above species would be: 10, 4, 3, 2, 1, 1, and 1, respectively.

Cat-tails, both *Typha latifolia* and *T. angustifolia*, are found on the study area and they are apparently equally suitable so far as nesting purposes are concerned. They constitute about 6% of the area of nesting vegetation and occur in strips along channel banks and in more extensive patches in the lower marshes. They reach heights of nine or ten feet in water ten to twenty inches deep; but grow also in shallower water and even on moist ground, though less luxuriantly. The stems seldom number more than one per linear foot and since the old vegetation does not produce a solid covering above water, ducks nesting among cat-tails must build platforms upon which to place their nests. In this respect utilization of the cover is quite similar to that of alkali bulrush.

Ninety-four nests or 4% of the total number were in cat-tails, and, as with alkali bulrush, the principal users were the ruddy (7 nests, 14%) and redhead (40 nests, 12%). The mallard was the only other species that used this cover to any appreciable extent. The order of use for all species was: mallard, 23 nests, 7%; cinnamon teal, 12, 2%; pintail, 4, 2%; and gadwall, 8, 1%. Appraisal of the value of cat-tail cover for the above species, respectively, is: 14, 12, 7, 22, and 1.

Saltgrass is the second most extensive cover plant occupying 26% of the marsh area in Unit II. It forms a dense

ground cover that is sufficiently high (in most places, 8–10 inches) to offer good concealment to nesting birds. More than 50% of it, however, was flooded throughout June, thus reducing the nesting possibilities considerably.

Nests of 525 ducks, representing 22% of the total, were found in saltgrass. It was of most importance to the shoveller (24 nests, 65%), to the cinnamon teal (261, 50%), and to the pintail (96, 46%). Surprisingly, it was used also to a considerable extent (10 nests, 20%) by the ruddy duck, a species whose nesting is usually regarded as being restricted to the cover of emergent aquatic plants. The use of saltgrass by other species was as follows: gadwall (81 nests 9%), redhead (31, 9%), and mallard (22, 7%). More nests would have been located in saltgrass, no doubt, had more of it been above water during the nesting season. Its relative use by the various ducks, however, would probably not have been much changed; that value, under the conditions, may be expressed as for the shoveller, 9; the cinnamon teal, 7; the pintail, 7; the ruddy, 3; and the gadwall, redhead, and mallard, 1 each.

Cane (Phragmites) is one of the less abundant plants occurring in well scattered patches in the lower parts of the marsh and occupying less than 1%. It grows to a height probably greater than any of the other covers, but owing to the fact that it usually occurs in shallow water and breaks off several feet above the ground, it offers few good nesting sites. The broken stems, however, were commonly used by Brewster's egret and other herons in nest construction. Sixty-eight duck nests, 3% of the total, were found in cane distributed by species as follows: gadwall, 33, 4%; mallard, 15, 5%; pintail, 6, 3%; redhead, 7, 2%; and cinnamon teal, 7, 1%.

Three species of willow (*Salix exigua, S. amygdaloides, S. lutea*) are found on the channel banks of the upper marsh. They are chiefly shrubby in character, forming a dense tangle of brush with an understory mainly of weeds. An occasional willow reaches the proportions of a tree and is used for perches by magpies during the nesting season. Nests among willows were relatively safe from flooding since the trees were growing on the bank elevations as shown in Plate 1 (upper).

The number of nests found among willows totaled 230 or 9%. The chief nester in this cover was the gadwall with 178 nests, 19%. Four other species using willow to some extent were: pintail, 17, 8%; mallard, 18, 6%; cinnamon teal, 14, 3%; and shoveller, a single nest. The two species of diving ducks were not represented. An evaluation of this cover for the several ducks is: gadwall, 6; pintail, 3; mallard, 2; cinnamon teal, 1; and 0 for the other species.

A large majority of the plant species in the area are herbs which have been listed in this study as "weeds." These, however, occupy less than 1% of the area and, like the willow, are limited to the higher channel banks in the upper parts of the marsh. The most important of these weeds are:

Ragweed—*Ambrosia elatior*
Wormweed—*Ambrosia biennis*
Salt bush—*Atriplex hastata*
Sea blite—*Bassia hyssopifolia*
Wild mustard—*Brassica nigra*
Blackweed—*Dondia* spp. (*intermedia* and *speciosa*)
Squawweed—*Grindelia squarrosa*
Sunflower—*Helianthus nuttallii*

Marsh elder—*Iva axillaris*
Wild lettuce—*Lactuca scariola*
Waterhoarhound—*Lycopus asper*
Black medick—*Medicago lupulina*
White sweetclover—*Melilotus alba*
Catnip—*Nepeta cataria*
Fivefinger—*Potentilla anserina*
Wild rose—*Rosa spaldingii*
Yellow senecio—*Senecio hydrophilus*
Stinging nettle—*Urtica brewerii*

Their use for nesting cover depends almost entirely on the abundance of the current year's growth as the old plants present only a sparse, skeleton-like appearance at the beginning of the nesting season.

Like the willows, these species are used chiefly by the gadwall which had 170 nests or 18% of its total in this type. Other ducks using this cover were: cinnamon teal, 40 nests, 8%; shoveller, 2, 7%; pintail, 11, 5%; mallard, 9, 3%; the divers, again, did not use this cover. The comparative value of weeds to nesting wild fowl, taking the mallard as the unit, would be: gadwall, 6; cinnamon teal, 3; shoveller, 2; pintail, 2; and mallard, 1.

Several other plant communities were utilized slightly by nesting ducks. Together they constituted less than 1% of the total emergent vegetation. Rush (*Juncus balticus*), sedge (*Carex nebraskensis*), foxtail barley (*Hordeum jubatum*), and arrowgrass (*Triglochin maritima*), occurred in dense, scattered communities over the higher levels of the marsh and their early vegetation attracted the nesting birds.

The gadwall used these covers to a greater extent than any other duck species, having 48 nests in rush and sedge, 51 in foxtail, and 12 in arrowgrass; cinnamon teal was next with 25, 19, and 6 nests respectively; while twenty nests of 3 other species of ducks were distributed about equally between the three types of cover. For none of the ducks did nesting exceed five per cent in any of these groups. The comparative use value of these three covers is:

Rush and sedge: pintail, 1; mallard, 3; ruddy, 4; and gadwall and cinnamon teal, 4.
Arrowgrass: cinnamon teal, 1; pintail, 2, and gadwall, 2.
Foxtail barley: pintail, 1; gadwall and cinnamon teal, 2.

In regard to the relative importance of the plant covers to the ducks as a whole, the reader is referred to Table 1 and to the first chart in Figure 4. It is apparent that of the four major cover types, hardstem bulrush was by far the most valuable for nesting. The fact that the 3% area of this cover harbored 39% of the nests in contrast to the 59% alkali bulrush with only 5% of the nests, accounts for the startling difference between per cent acre-use ratios of the two cover types. Of the other extensive cover types, saltgrass and cat-tails were determined as having per cent acre-use ratios of 1.68 and .66, respectively, which means that both are far below hardstem bulrush in cover value.

The ratios pertaining to the less extensive cover plants should be interpreted with caution, since they are based not only upon fewer records but also upon somewhat arbitrary acreages and would be reduced if the per cent acreages were greater. Of this group willow and weeds rank high, primarily due to the choice of nesting sites by the gadwall. The order of preference for

other covers is sedge and rush, cane, foxtail, and arrowgrass.

From field observations it was apparent that the greater concentrations of gadwall nests were among willows and weeds. Next in importance to the gadwall was hardstem bulrush, and the two covers of least importance were alkali bulrush and cat-tail. For the cinnamon teal, weeds and hardstem bulrush were of about equal value and lead in rank, with cat-tails and alkali bulrush again the least important. The redhead, mallard, and the ruddy favored the hardstem bulrush, other covers used by these species having much lower per cent acreage-use ratios. The order rank of the other major cover types for these three ducks was in each instance: cat-tail, saltgrass, alkali bulrush. The per cent acreage-use ratios for the pintail indicated that the values of hardstem bulrush and willow were highest and about on a par, and that weeds were next in importance. The shoveller was the only duck other than the gadwall that seemed to prefer weed cover over hardstem bulrush. Since this result was based upon so few nests, however, it has little value for comparative purposes, and observations indicated that the shoveller liked saltgrass very much more than any other available nesting cover.

DUCK NESTING DENSITIES

Examination of the completed duck nesting maps showed that for each species there is a center of distribution for the nests, though the groupings for the mallard and redhead are quite similar. Since there is almost unlimited food and water in the area, these distribution centers may well be interpreted as places of optimum nesting value to the species.

In order to appraise these values, data for the east side of what is known as Blodgett's Channel and for a strip on the west side of the old river channel were segregated. These tracts were selected because the waterway named runs through the center of the gadwall, mallard, and redhead areas, while the strip mentioned is intensively used by the cinnamon teal. Both areas were covered thoroughly during the investigation.

In calculating acreage, since 90 to 95% of the duck nests located during the study were within forty-five feet of channels, this figure was taken as the width of the nesting area, while the length was scaled off on the cover map. As shown in Table 2, the area along the selected reaches of the channels was calculated and the number of nests found therein counted from the nesting maps; the number of nests per acre by species was calculated from these figures.

It will be noted that the maximum densities vary with both the species and the areas. Bens-Blodgetts and upper Blodgetts areas have 79 and 72 nests per acre of which 55 and 46, respectively, are of gadwalls. The former is practically all of the willow and weed type as shown on the left side of Plate 2 (upper), with a strip of salt-grass on the outside that attracted cinnamon teals to the extent of 9 nests per acre which is nearly the highest density found for the species. This strip did not, however, have the highest mallard or redhead densities, a finding probably correlated with the lack of hardstem bulrush. Upper Blodgetts is quite similar with

the zones becoming somewhat narrower.

Middle Blodgetts is almost entirely a hardstem bulrush cover type and has a high redhead density. This is the first of the areas under consideration which is below the 4,205 contour line, and it was about half flooded during the nesting season. Lower Blodgetts is typical of the lower reaches of the marsh with both alkali and hardstem bulrush present, and since it is below the 4,204 contour line, it was all flooded during the nesting season. It will be seen that redhead densities were the highest here and that one ruddy nest was located. The only other duck found nesting was the cinnamon teal, possibly in redhead built nests. The channel known as the old river channel, with the exception of a very narrow band of hardstem bulrush at the edge of the water, is lined with saltgrass to a width of 90–100 feet, one half of which was flooded. This grass was apparently of especial value for the cinnamon teal as the density of nests was ten per acre. Other ducks nested here only sparsely.

TABLE 2
DUCK NESTING DENSITIES

Channel	Bens-Blodgetts	Upper Blodgetts	Middle Blodgetts	Lower Blodgetts	Old Channel	Total Nests	Nests per Acre
Cover	Willow Weeds	Willow Weeds Hardstem Bulrush	Hardstem Bulrush	Alkali and Hardstem Bulrushes	Salt-grass	All	**3,000 acres
Acreage	1.0	1.0	1.5	2.0	2.7		
Gadwall	55	46	16	0	1	928	.31
	*(55)	(46)	(24)		(3)		
Cinnamon Teal	9	6	6	2	10		
	(9)	(6)	(9)	(4)	(27)	524	.17
Redhead	5	5	10	11	1		
	(5)	(5)	(15)	(22)	(3)	343	.11
Mallard	8	8	14	0	1		
	(8)	(8)	(21)		(3)	312	.10
Pintail	2	7	4	0	1		
	(2)	(7)	(6)		(3)	208	.07
Ruddy	0	0	1.5	1	0	50	.016
			(2)	(2)			
Shoveller	0	0	0	0	1	37	.01
					(3)		
TOTAL	79	72	51.5	14.0	15	2,402	.8

* Figures in parentheses indicate number of nests found in area.
** Planimeter reading Plate 1, 2,947 acres.

The high densities noted characterize only limited areas and are not to be used for calculating nest capacity of large tracts. The last two columns of Table 2 indicate the total number of

nests, and the number of nests per acre for the entire study area. It is believed that the .8 nests per acre found on the area represent an average where extensive tracts of suitable cover are available on the refuge. All of the above calculations have been on the basis of nests actually found. If we assume that there were 3,000 nests in the area, as

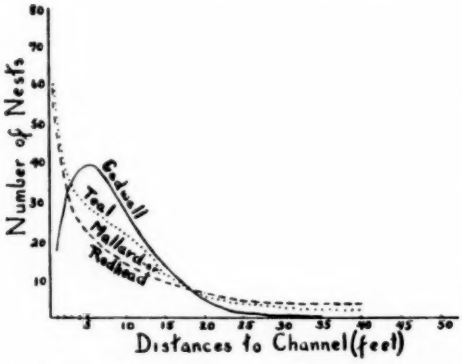


Fig. 5. Curves showing the relation of nesting sites to channels as expressed by the distances of nests of the four important species of ducks from channel banks.

justified on pages 31–32, the density would be 1.0 nests per acre. It would be of great interest to have comparable figures for other areas where conditions are perhaps more favorable for such species as the pintail and shoveller. It is thought that the Bear River data on gadwall, redhead, and cinnamon teal my represent optima for these ducks.

CHANNEL RELATIONSHIPS

The distance of each nest from a channel or from open water was recorded with the view of determining the influence of this factor on nest location. From the data obtained, it was apparent that the ducks selected nesting sites primarily on the basis of the character of the vegetation. Channels, however, influence both the character and distribution of the vegetation to such an extent that their importance to nesting birds should not be overlooked.

Though other areas were searched with the same thoroughness, approximately 95% of all the duck nests found were within forty-five feet of channels. The curves in Figure 5 are indicative of the indirect influence of channels on the selection of nesting sites. The mallard and redhead, which used the hardstem bulrush most extensively, show identical curves, with the peak for locations very close to channel edges and with a rather uniform decline for more remote situations. In the case of the cinnamon teal, the secondary leveling of the curve is accounted for by the extensive use of saltgrass, a cover more distant from the channels. The curve for the pintail would be quite similar to that of the teal.

The gadwall curve shows a peak for sites 5 to 6 feet from channels, due to the use by this bird of the willow and weed zones that are just outside the hardstem bulrush on the upper channels.

Channels and channel vegetation apparently exerted but little influence on the selection of nesting sites by the ruddy and shoveller, both species nesting in greater numbers some distance from channels. In each case, however, there were more nests within 15 feet of channels than beyond that distance.

HEIGHT OF NESTS ABOVE BOTTOM

The data obtained on the height of nests above the ground is of particular interest in relation to the flooding of nests. Practically all of the nests had the inside bottom of the bowl within

three inches of the mud, 96% in the case of the shoalwater ducks and 70% of the divers. The ruddy duck and the redhead had 52% and 25% of their nests, respectively, between three and eight inches of the bottom. This was to be expected of these species, since the greater number of their nests were located in cat-tail, alkali bulrush, and hardstem bulrush. In all other cover types 99% of the nests were within three inches of the mud.

TABLE 3
FATE OF EGGS

Species	Number of Nests	Number of Eggs	Hatched	Deserted	Preyed On	Flooded	Out of Nest	Miscellaneous Losses	Unknown Causes
Gadwall	660	6,000	5,106	130	291	91	3	—	379
	(71)		(85)	(2)	(5)	(1)	—	—	(7)
Cinnamon Teal	326	2,655	2,232	142	69	77	3	—	132
	(62)	—	(84)	(6)	(2)	(3)	—	—	(5)
Redhead	212	2,651	677	137	170	694	98	5	870
	(62)		(26)	(5)	(6)	(26)	(4)	—	(33)
Mallard	185	1,582	953	97	52	99	3	4	374
	(59)	—	(60)	(6)	(3)	(6)	—	—	(24)
Pintail	135	969	796	11	41	21	—	18	82
	(65)	—	(82)	(1)	(4)	(2)		(2)	(8)
Shoveller	23	189	152	13	13	—	—	—	11
	(62)	—	(80)	(7)	(7)	—	—	—	(6)
Ruddy	19	158	82	32	—	25	3	1	15
	(38)	—	(52)	(20)	—	(16)	(2)	—	(10)
TOTAL	1,560	14,204	9,998	562	636	1,007	110	28	1,863

FLUSHING DISTANCES

Flushing distance data of the study demonstrate the tendency of waterfowl to sneak from their nests when danger approaches. With every species, except the shoveller, at least 50% of the nest visits were recorded with no flushing. In the case of the shoveller, ten nests were located without flushing the female and all but one of the forty-six flushings, were less than ten feet distant. For the ruddy and redhead only 42 flushings were recorded in 387 visits. Of a total of 2,720 records, in only 94 was the distance involved greater than ten feet. This would indicate that if the bird flushes from the nest rather than sneaking off, she sits exceedingly close. There was a distinct reduction in the flushing distances and an increased amount of sneaking from nests about the first of July.

BIOTIC POTENTIAL AND ENVIRONMENTAL RESISTANCE

Having considered the bearing of cover types and other environmental influences on the choice of nesting sites by the various duck species, it is desirable to call attention to the biotic potential of the ducks and to environmental re-

sistance during the nesting period. These data pertinent to ducks as a group are condensed in Table 3, while those relating to individual species are presented in Tables 4–10 in the appendix. The following discussions are

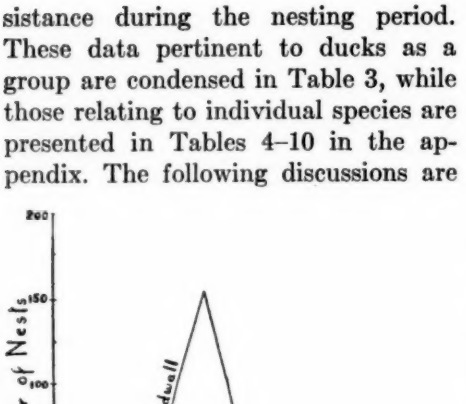


Fig. 6. Curves showing the clutch size class frequencies for the five more common nesting ducks.

based only upon nests for which complete histories were obtained.

Figure 6 summarizes the information on clutch sizes for the five most abundant nesters. It will be seen that the peak of frequencies for the gadwall is at ten eggs per nest; for the cinnamon teal, at nine and ten; for the mallard, at eight; and for the pintail, at seven and eight. Data for the shoveller and ruddy ducks were too incomplete to show definite peaks, their averages being 8.2 and 8.3, respectively. No definite peak is apparent for the redhead, its average being 12.5 eggs per nest. For some reason, there was a large number of community nests for this bird, one with 39 eggs being found; almost invariably the number of eggs hatched in these composite clutches was very small. No definite correlation of cover types with clutch size was found. It is worthy of note, however, that in all but the cinnamon teal the largest average clutch size was found in the cover type that had the highest percentage acre-use ratio.

The success of nesting was surprisingly high for four species, the gadwall, cinnamon teal, pintail, and shoveller hatching between 80 and 85% of all the eggs laid. The mallard fell considerably below this mark with a 60% hatch; while the ruddy duck hatched only 52%. The lowest rate (26%) was that of the redhead.

As already reported for the Canada goose, (1, p. 85) saltgrass was the best cover for success in nesting. The hatch in this cover was 87%, a rate closely followed by willow, weeds, and foxtail. The lowest hatch in a particular cover type was for alkali bulrush where only 44% of the eggs hatched. The hardstem bulrush was about midway between these two extremes with a percentage of 58.

The causes of egg loss have been listed in six categories in tables in the appendix. Each will be discussed separately and in a comparative manner as between species of ducks and cover types.

Desertion was found to be a minor cause of loss for all species of ducks except the ruddy, which had 20% of its eggs fail to hatch, presumably due to this cause. It is possible that the percentage of the redhead egg losses placed in the column "Unknown" should be to some extent shifted to this category, which would make desertions an important cause of egg mortality for both of the diving ducks included in this study. It is the impression of the

authors that egg losses due to the activities of the field crew during the study were perhaps considerable for these two species but of minor importance for the other ducks.

Predation was found to be of small importance, causing less than 7% of the egg losses of all ducks. Among possible predators the following were observed during the study: skunk, weasel, muskrat, meadow mouse, California gull, raven, magpie. Nearly all of the depredations were by the magpie, and occurred largely in the hardstem bulrush, weeds, willow, and saltgrass near upper channels. A map of destroyed nests showed that most of them were adjacent to areas in which there were mature willow trees, and field observations showed that the magpies used these for perches and were rarely seen during the nesting season more than a few feet from them. The shrubby willows did not provide suitable magpie perches. Most of the duck nests were very well concealed and apparently were found by the magpies only after long observation from the willow perches.

Egg losses due to flooding in 1937 were of importance for only the two diving ducks. For the other species losses were less than 6%; in fact, only in the case of the mallard did the figure reach more than 1%. On the other hand, 26 and 16% respectively, of the ruddy and redhead losses were attributed to flooding. Examination of the nesting maps will show that these two species nested more towards the lower parts of the marsh, mostly below the 4,205 contour line. Water level recorders were maintained throughout the study at two locations, one being well down in the unit and the other on one of the upper channel banks. These gauges showed that south winds might raise the water in the nesting area from four-tenths to seven-tenths of a foot in a few hours. Analysis of the data, using a map showing the location of flooded nests and a comparative table of the various cover types, revealed that most of the flooding during the present study was in cat-tail, alkali bulrush, cane, and hardstem bulrush in the order named. These facts are all interlocking in their significance demonstrating that under normal conditions the nests built at the lower levels and usually in shallow water are exposed to the greatest flooding hazard.

It must be stated, however, that 1937 was the first year in some time that the spring floods did not cause the river to overflow its banks during June. In past years there have been heavy losses due to flooding for all ducks, even those that nested in the upper parts of the marsh.

Two loss categories of minor importance remain to be mentioned. In a few instances, eggs were pushed out of nests presumably by the incubating birds. This was found to be most common with the redhead and especially when large clutches, probably representing contributions by several birds, were found. The eighteen pintail eggs listed as lost due to miscellaneous causes were in two nests, the sitting females dying on the nests from an undetermined cause. All other egg losses listed as miscellaneous refer to the young birds dying before they could free themselves from the eggshell.

Losses due to unknown causes are

important with all species. This category includes infertile eggs which probably account for most of the entries. A great majority of the eggs listed in this category occurred as one or two left in a nest after the others had hatched. In the case of the redhead, where 33% of the eggs are recorded as not hatched—cause unknown, the eggs which failed to hatch in community nests were entered in this column. By way of example, the data on nest No. 1,519 may be cited: This nest was found in hardstem bulrush on June 14 with 24 eggs in it. It was revisited on June 28 when it had the same number of eggs. The concluding visit was on July 21 when the membranes of 3 eggs which had hatched were found and 21 eggs not hatched were still in the nest. This is quite typical of the 52 redhead nests that contained more than 15 eggs per nest.

SUMMARY

1. The nesting season for waterfowl other than geese on the Bear River Refuge during 1937 began in early May and extended into mid-August. The peak of hatching for eggs of all duck species was about July 20.

2. A population of 3,000 pairs of ducks was estimated to have nested in approximately 3,000 acres of potential nesting cover of Unit II. Actually, 2,410 nests of nine species of ducks were found, the most numerous being those of the gadwall.

3. The distribution, character, and use of nesting vegetation by the several duck species are discussed and per cent-acreage-use ratios are given as evaluations of the different types of vegetative cover.

4. Ninety to ninety-five per cent of the nests found were located within forty-five feet of channels. The densest population, 79 nests per acre, was found among weeds and willows of the upper marsh. An average nesting density of 1.0 nests per acre was found for the 3,000 acres of available vegetation.

5. The influence of channels on the selection of nesting sites is considered, as are also heights of nests above bottom, and flushing distances. Channels are regarded as most important through their influence on the character and distribution of the better nesting cover types. In cover types other than cat-tail, alkali bulrush, and hardstem bulrush, 99% of the nests were within three inches of the soil. Data on flushing distances indicated that more than half of the incubating birds sneaked from the nest at the approach of danger. Of 2,720 flushes in only 94 instances was the distance from the nest greater than ten feet.

6. In 1,560 nests 14,204 eggs were found. Of these eggs, 9,998 hatched, and 4,206 did not hatch because of several causes which are discussed. The data pertinent to individual species are condensed in tables for comparative purposes.

LITERATURE CITED

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APPENDIX

Tables 4–10 present detailed data of the study relative to individual duck species; the figures in parentheses are percentages.

TABLE 4
GADWALL

Cover Type	Number of Nests Found	Distance to Channel (steps)				Height of Nest above Mud (inches)				Number Nests Terminated	Total Number of Eggs	Fate of Eggs						
													Not Hatched					
		0–5	6–15	16–50	50+	0–3	4–8	9–12	13+			Hatched	Deserted	Preyed On	Flooded	Out of Nest	Misc.	Unknown
Hardstem bulrush	308	138	151	19	—	307	1	—	—	211	1,952	1,660	56	52	61	—	—	123
	(33)	(45)	(49)	(6)		(100)	—	—	—	(68)	—	(85)	(3)	(3)	(3)	—	—	(6)
Alkali bulrush	39	7	23	6	3	39	—	—	—	25	209	179	—	—	3	—	—	27
	(4)	(18)	(59)	(15)	(7)	(100)	—	—	—	(65)	—	(86)	—	—	(1)	—	—	(13)
Saltgrass	81	13	28	26	14	81	—	—	—	44	347	310	3	20	—	—	—	14
	(9)	(16)	(35)	(32)	(17)	(100)	—	—	—	(54)	—	(89)	(1)	(6)	—	—	—	(4)
Cat-tails	8	1	3	4	—	8	—	—	—	6	99	91	1	—	7	—	—	—
	(1)	(12)	(38)	(50)	—	(100)	—	—	—	(75)		(92)	(1)	—	(8)	—	—	—
Willow	178	95	79	4	—	178	—	—	—	133	1,306	1,173	11	69	—	—	—	53
	(19)	(53)	(44)	(3)	—	(100)	—	—	—	(75)		(90)	(1)	(5)	—	—	—	(4)
Weeds	170	89	71	10	—	170	—	—	—	132	1,162	939	14	107	—	3	—	99
	(18)	(52)	(42)	(6)	—	(100)	—	—	—	(78)		(80)	(2)	(9)	—	—	—	(9)
Cane	33	14	18	1	—	33	—	—	—	23	211	165	—	13	20	—	—	13
	(4)	(43)	(55)	(2)	—	(100)	—	—	—	(70)		(78)	—	(6)	(10)	—	—	(6)
Foxtail barley	51	9	33	8	1	51	—	—	—	33	293	259	11	—	—	—	—	23
	(5)	(18)	(65)	(16)	(1)	(100)	—	—	—	(65)		(88)	(4)	—	—	—	—	(8)
Arrowgrass	12	1	3	8	—	12	—	—	—	6	36	29	1	2	—	—	—	4
	(2)	—	(25)	(75)	—	(100)	—	—	—	(50)		(81)	(3)	(5)	—	—	—	(11)
Other sedges	48	8	23	17	—	48	—	—	—	43	385	301	33	28	—	—	—	23
	(5)	(17)	(48)	(35)	—	(100)	—	—	—	(90)		(78)	(9)	(7)	—	—	—	(6)
TOTALS	928	375	432	103	18	927	1	—	—	660	6,000	5,106	130	291	91	3	—	379
		(41)	(47)	(11)	(1)	(100)	—	—	—	(71)		(85)	(2)	(5)	(1)	—	—	(7)

TABLE 5
CINNAMON TEAL

Cover Type	Number of Nests Found	Distance to Channel (steps)				Height of Nest above Mud (inches)				Number Nests Terminated	Total Number of Eggs	Fate of Eggs						
													Not Hatched					
		0–5	6–15	16–50	50+	0–3	4–8	9–12	13+			Hatched	Deserted	Preyed On	Flooded	Out of Nest	Misc.	Unknown
Hardstem bulrush	122	79	37	6	—	112	7	3	—	81	635	444	68	27	25	—	—	71
	(23)	(65)	(30)	(5)	—	(92)	(6)	(2)	—	(66)		(70)	(11)	(4)	(4)	—	—	(11)
Alkali bulrush	18	7	10	1	—	18	—	—	—	6	48	42	—	—	—	—	—	6
	(3)	(39)	(56)	(5)	—	(100)	—	—	—	(33)	(2)	(87)	—	—	—	—	—	(13)
Saltgrass	261	45	132	79	5	255	6	—	—	153	1,291	1,171	24	29	28	3	—	36
	(50)	(17)	(51)	(31)	(1)	(98)	(2)	—	—	(59)	(49)	(91)	(2)	(2)	(2)	—	—	(3)
Cat-tails	12	7	4	1	—	8	3	1	—	4	34	32	—	—	—	—	—	2
	(2)	(58)	(33)	(9)	—	(75)	—	—	—	(33)	(1)	(99)	—	—	—	—	—	(1)
Willow	14	7	7	—	—	14	—	—	—	8	58	52	6	—	—	—	—	—
	(3)	(50)	(50)	—	—	(100)	—	—	—	(57)	(2)	(90)	(10)	—	—	—	—	—
Weeds	40	22	14	4	—	40	—	—	—	31	238	220	10	1	—	—	—	7
	(8)	(55)	(50)	(10)	—	(100)	—	—	—	(78)	(9)	(93)	(4)	—	—	—	—	(3)
Cane	7	4	3	—	—	7	—	—	—	5	37	18	—	—	19	—	—	—
	(1)	(57)	(43)	—	—	(100)	—	—	—	(71)	(1)	(49)	—	—	(51)	—	—	—
Foxtail barley	19	5	10	4	—	19	—	—	—	16	138	117	16	—	—	—	—	5
	(4)	(26)	(53)	(21)	—	(100)	—	—	—	(84)	(5)	(84)	(12)	—	—	—	—	(4)
Arrowgrass	6	—	2	4	—	6	—	—	—	4	25	17	—	3	5	—	—	—
	(1)	—	(33)	(66)	—	(100)	—	—	—	(66)	(1)	(68)	—	(12)	(20)	—	—	—
Other sedges	25	4	16	4	1	25	—	—	—	18	151	119	18	9	—	—	—	5
	(5)	(16)	(64)	(16)	(4)	(100)	—	—	—	(72)	(6)	(78)	(12)	(6)	—	—	—	(3)
TOTALS	524	180	235	103	5	504	16	4	—	326	2,655	2,232	142	69	77	3	—	132
		(35)	(45)	(20)	(5)	(96)	(3)	(1)	—	(62)		(84)	(6)	(2)	(3)	—	—	(5)

TABLE 6
REDHEAD

Cover Type	Number of Nests Found	Distance to Channel (steps)				Height of Nest above Mud (inches)				Number Nests Terminated	Total Number of Eggs	Fate of Eggs						
													Not Hatched					
		0–5	6–15	16–50	50+	0–3	4–8	9–12	13+			Hatched	Deserted	Preyed On	Flooded	Out of Nest	Misc.	Unknown
Hardstem bulrush	222	102	88	29	3	166	52	4	—	146	1,932	522	130	112	353	57	3	755
	(65)	(46)	(40)	(13)	(1)	(76)	(23)	(1)	—	(66)	(73)	(27)	(7)	(6)	(18)	(3)	—	(39)
Alkali bulrush	37	12	10	12	3	22	14	1	—	22	274	33	2	13	168	26	—	32
	(11)	(33)	(27)	(33)	(7)	(60)	(38)	(2)	—	(60)	(10)	(12)	—	(3)	(61)	(11)	—	(12)
Saltgrass	31	4	13	10	4	28	3	—	—	20	177	89	3	18	31	15	2	19
	(9)	(13)	(42)	(32)	(13)	(90)	(10)	—	—	(65)	(7)	(50)	(1)	(10)	(18)	(8)	(1)	(11)
Cat-tails	40	21	13	3	3	22	16	—	2	15	162	8	—	—	140	—	—	14
	(12)	(53)	(33)	(7)	(7)	(55)	(40)	—	(5)	(37)	(6)	(5)	—	—	(86)	—	—	(9)
Willow	2	1	1	—	—	2	—	—	—	1	14	11	—	—	—	—	—	3
	—	(50)	(50)	—	—	(100)	—	—	—	(50)	—	(79)	—	—	—	—	—	(21)
Weeds	2	—	2	—	—	2	—	—	—	1	14	—	—	14	—	—	—	—
		—	(100)	—	—	(100)	—	—	—	(50)	—	—	—	(100)	—	—	—	—
Cane	7	2	3	—	2	7	—	—	—	6	72	14	2	7	2	—	—	47
	(2)	(28)	(43)	—	(28)	(100)	—	—	—	(86)	(3)	(20)	(2)	(10)	(2)	—	—	(65)
Foxtail barley																		
Arrowgrass																		
Other sedges	2	1	1	—	—	2	—	—	—	1	6	—	—	6	—	—	—	—
	—	(50)	(50)	—	—	(100)	—	—	—	(50)	—	—	—	(100)	—	—	—	—
TOTALS	343	143	131	54	15	251	85	5	2	212	2,651	677	137	170	694	98	5	870
		(42)	(38)	(16)	(4)	(73)	(24)	(2)	(1)	(62)		(26)	(5)	(6)	(26)	(4)	—	(33)

TABLE 7
MALLARD

Cover Type	Number of Nests Found	Distance to Channel (steps)				Height of Nest above Mud (inches)				Number Nests Terminated	Total Number of Eggs	Fate of Eggs						
													Not Hatched					
		0–5	6–15	16–50	50+	0–3	4–8	9–12	13+			Hatched	Deserted	Preyed On	Flooded	Out of Nest	Misc.	Unknown
Hardstem bulrush	203	106	70	24	3	175	18	6	4	117	1031	545	96	42	86	3	4	255
	(65)	(52)	(34)	(12)	(2)	(86)	(9)	(3)	(2)	(58)	(65)	(53)	(9)	(4)	(8)	—	—	(25)
Alkali bulrush	12	2	6	4	—	9	3	—	—	5	41	18	—	—	8	—	—	15
	(4)	(17)	(50)	(33)	—	(75)	(25)	—	—	(42)	(2)	(45)	—	—	(18)	—	—	(37)
Saltgrass	22	2	10	8	2	22	—	—	—	14	110	94	—	—	5	—	—	11
	(7)	(4)	(45)	(37)	(4)	(100)	—	—	—	(64)	(7)	(86)	—	—	(4)	—	—	(10)
Cat-tails	23	20	—	3	—	18	3	—	2	12	87	62	—	—	—	—	—	25
	(7)	(87)	—	(13)	—	(78)	(12)	—	(10)	(52)	(5)	(71)	—	—	—	—	—	(29)
Willow	18	10	7	1	—	17	—	—	1	14	127	90	—	6	—	—	—	31
	(6)	(56)	(39)	(5)		(95)	—	—	(5)	(78)	(8)	(71)	—	(5)	—	—	—	(24)
Weeds	9	5	3	1	—	9	—	—	—	7	45	38	1	1	—	—	—	5
	(3)	(56)	(33)	(10)	—	(100)	—	—	—	(78)	(2)	(85)	—	—	—	—	—	(14)
Cane	15	8	7	—	—	15	—	—	—	9	85	60	—	—	—	—	—	
	(5)	(53)	(47)	—	—	(100)	—	—	—	(60)	(5)	(71)	—	—	—	—	—	(29)
Foxtail barley																		
Arrowgrass																		
Other sedges	10	2	1	6	1	10	—	—	—	7	56	46	—	3	—	—	—	7
	(3)	(20)	(10)	(60)	(10)	(100)	—	—	—	(70)	(2)	(82)	—	(5)	—	—	—	(13)
TOTALS	312	155	104	47	6	275	24	6	7	185	1582	953	97	52	99	3	4	374
		(50)	(33)	(15)	(2)	(88)	(8)	(2)	(2)	(59)		(60)	(6)	(3)	(6)	—	—	(24)

TABLE 8
PINTAIL

Cover Type	Number of Nests Found	Distance to Channel (steps)				Height of Nest above Mud (inches)				Number Nests Terminated	Total Number of Eggs	Fate of Eggs						
													Not Hatched					
		0–5	6–15	16–50	50+	0–3	4–8	9–12	13+			Hatched	Deserted	Preyed On	Flooded	Out of Nest	Misc.	Unknown
Hardstem bulrush	54	18	29	7	—	52	—	—	2	40	299	223	5	2	21	—	9	39
	(26)	(33)	(54)	(13)	—	(97)	—	—	(3)	(74)	(31)	(75)	(2)	—	(7)	—	(3)	(13)
Alkali bulrush	10	2	5	2	1	9	1	—	—	8	59	34	—	6	—	—	9	10
	(5)	(20)	(50)	(20)	(10)	(90)	(10)	—	—	(80)	(6)	(58)	—	(10)	—	—	(15)	(17)
Saltgrass	96	11	64	17	4	94	—	—	2	60	416	369	6	25	—	—	—	16
	(46)	(11)	(67)	(18)	(4)	(98)	—	—	(2)	(62)	(43)	(89)	(1)	(6)	—	—	—	(4)
Cat-tails	4	2	2	—	—	4	—	—	—	2	20	14	—	—	—	—	—	6
	(2)	(50)	(50)	—	—	(100)	—	—	—	(50)	(2)	(70)	—	—	—	—	—	(30)
Willow	17	10	5	2	—	17	—	—	—	7	53	52	—	—	—	—	—	1
	(8)	(59)	(30)	(11)	—	(100)	—	—	—	(41)	(5)	(99)	—	—	—	—	—	(1)
Weeds	11	6	4	1	—	9	1	1	—	8	58	53	—	2	—	—	—	3
	(5)	(55)	(36)	(9)	—	(82)	(9)	(9)	—	(73)	(6)	(92)	—	(3)	—	—	—	(5)
Cane	6	3	3	—	—	6	—	—	—	3	19	12	—	—	—	—	—	7
	(3)	(50)	(50)	—	—	(100)	—	—	—	(50)	(2)	(63)	—	—	—	—	—	(37)
Foxtail barley	5	2	3	—	—	5	—	—	—	3	21	21	—	—	—	—	—	—
	(2)	(40)	(60)	—	—	(100)	—	—	—	(60)	(2)	(100)	—	—	—	—	—	—
Arrowgrass	2	1	1	—	—	2	—	—	—	1	7	7	—	—	—	—	—	—
	(1)	(50)	(50)	—	—	(100)	—	—	—	(50)	(1)	(100)	—	—	—	—	—	—
Other sedges	3	2	—	1	—	3	—	—	—	3	17	11	—	6	—	—	—	—
	(1)	(67)	—	(33)	—	(100)	—	—	—	(100)	(2)	(65)	—	(35)	—	—	—	—
TOTALS	208	57	116	30	5	201	2	1	4	135	969	796	11	41	21	—	18	82
		(27)	(56)	(14)	(3)	(98)	—	—	(2)	(65)		(82)	(1)	(4)	(2)	—	(2)	(8)

TABLE 9
RUDDY

Cover Type	Number of Nests Found	Distance to Channel (steps)				Height of Nest above Mud (inches)				Number Nests Terminated	Total Number of Eggs	Fate of Eggs						
													Not Hatched					
		0–5	6–15	16–50	50+	0–3	4–8	9–12	13+			Hatched	Deserted	Preyed On	Flooded	Out of Nest	Misc.	Unknown
Hardstem bulrush	16	5	11	—	—	5	9	2	—	7	60	29	12	—	9	3	1	6
	(32)	(35)	(65)	—	—	(35)	(48)	(17)	—	(44)	(38)	(50)	(20)	—	(15)	(5)	—	(10)
Alkali bulrush	15	4	3	3	5	7	8	—	—	6	52	20	—	—	10	—	—	2
	(30)	(27)	(20)	(20)	(33)	(47)	(53)	—	—	(40)	(32)	(38)	(38)	—	(19)	—	—	(5)
Saltgrass	10	2	7	—	1	7	3	—	—	3	23	19	—	—	—	—	—	4
	(20)	(20)	(70)	—	(10)	(70)	(30)	—	—	(30)	(15)	(83)	—	—	—	—	—	(17)
Cat-tails	7	3	3	1	—	4	3	—	—	3	23	14	—	—	6	—	—	3
	(14)	(43)	(43)	(14)	—	(57)	(43)	—	—	(43)	(15)	(61)	—	—	(26)	—	—	(13)
Willow																		
Weeds																		
Cane																		
Foxtail barley																		
Arrowgrass																		
Other sedges	2	—	1	—	1	1	1											
	(4)		(50)		(50)	(50)	(50)											
TOTALS	50	14	25	4	7	24	24	2	—	19	158	82	32	—	25	3	1	15
		(28)	(50)	(8)	(14)	(48)	(48)	(4)	—	(38)	—	(52)	(20)	—	(16)	(2)	—	(10)

TABLE 10
SHOVELLER

Cover Type	Number of Nests Found	Distance to Channel (steps)				Height of Nest above Mud (inches)				Number Nests Terminated	Total Number of Eggs	Fate of Eggs						
													Not Hatched					
		0-5	6-15	16-50	50+	0-3	4-8	9-12	13+			Hatched	Deserted	Preyed On	Flooded	Out of Nest	Misc.	Unknown
Hardstem bulrush	7 (19)	5 (71)	2 (29)	— —	— —	5 (71)	2 (29)	— —	— —	3 (43)	28 (15)	25 (89)	— —	— —	— —	— —	— —	3 (11)
Alkali bulrush	3 (8)	— —	2 (66)	1 (33)	— —	3 (100)	— —	— —	— —	3 (100)	26 (14)	18 (69)	6 (23)	— —	— —	— —	— —	2 (8)
Saltgrass	24 (65)	4 (17)	9 (38)	8 (33)	3 (12)	24 (100)	— —	— —	— —	14 (58)	110 (58)	87 (79)	7 (6)	13 (12)	— —	— —	— —	3 (3)
Cat-tails																		
Willow	1 (1)	1 (100)	— —	— —	— —	1 (100)	— —	— —	— —	1 (100)	7 (3)	4 (57)	— —	— —	— —	— —	— —	3 (43)
Weeds	2 (7)	— —	2 (100)	— —	— —	2 (100)	— —	— —	— —	2 (100)	18 (100)	18 (100)	— —	— —	— —	— —	— —	— —
Cane																		
Foxtail barley																		
Arrowgrass																		
Other sedges																		
TOTALS	37	10 (27)	15 (41)	9 (24)	3 (8)	35 (95)	2 (5)	— —	— —	23 (62)	189	152 (80)	13 (7)	13 (7)	— —	— —	— —	11 (6)

EXPLANATION OF PLATES

The maps (plates 2–4) show the location of nests of the seven more abundant ducks found in Unit II of the Bear River Refuge in 1937. In plates 2-B, 3, and 4-A the solid dots represent one nest, the half blocked dots five nests, and the large crosses twenty nests of the gadwall, cinnamon teal, redhead, and mallard ducks, respectively. Plate 4-B shows the ruddy nests as solid dots, the shoveller's as circles, and the pintail's as small crosses. The heavy black lines show channel courses throughout the unit while the fainter lines show cover type or vegetation boundaries.

Cecil S. Williams
Wm. H. Marshall
Biological Survey
Brigham City, Utah

Unknown
3 (11)
2 (8)
3 (3)
3 (42)
—
—
11 (6)

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